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TRANSACTIONS
OF THE
BOTANICAL SOCIETY OF EDINBURGH.

SESSION LXXIII.

PRESIDENTIAL ADDRESS, NOVEMBER 1908.

By the kindness of the Assistant Secretary, Mr Jeffrey, I am able to submit the following state of the Roll of the Society:—

Honorary Fellows: British 6, Foreign 25. Ordinary Fellows: Resident 106, Non-Resident, 45. Corresponding Members 60; Associates 9; Lady Members 6. Total, 257.

During the past year the membership of the Society has been strengthened by the addition of:—Honorary British Fellow 1. Ordinary Fellows: Resident 7, Non-Resident 3; Lady Member 1. Total 12.

During the same period 5 Ordinary Fellows have resigned, and we have lost by death:—1 Royal Fellow (Oscar II., King of Sweden). Ordinary Fellows: Resident 5, Non-Resident 1, Corresponding Member 1. Total 8.

OSCAR II., KING OF SWEDEN.—The death on Sunday, 8th December 1907, at the Royal Palace at Stockholm, of Oscar II., King of Sweden, removed the only foreign royal name from their list of Fellows. The late king ascended the throne on 18th September 1872, and during his whole reign the feud between Sweden and Norway was acute, and ultimately resulted in the declaration of Norwegian independence. In 1899 he abdicated in favour of his son

Gustavus, but in a few months he resumed his kingship. In a position of almost unexampled difficulty he strove to preserve friendly relations between the two nations, and it is generally admitted that his personal intervention secured the avoidance of bloodshed in the revolution by which Sweden and Norway became separate kingdoms. By his actions throughout the long years of difficulty and contention he earned the enviable title of the Peacemaker.

While the late Professor J. Hutton Balfour was on a visit to Sweden, King Oscar made his acquaintance, and their common interest in natural science led to a personal friendship which resulted in King Oscar becoming a Fellow of the Society in 1877. Reference was made to the distinguished place occupied by King Oscar II. in science, art, poetry, and literature when recording his death at the December meeting of the Society in 1907 (see "Transactions," vol. xxiii., part iv., p. 306).

J. K. MILNE of Kevock Tower, Lasswade, became a Fellow in 1875, and died some time ago, no notice having reached us till recently.

FRANK C. CRAWFORD, who became a Fellow in July 1897, died suddenly at his residence, 19 Royal Terrace, Edinburgh, on 9th February 1908. He was the younger son of Adam Howden Crawford of the Hon. East India Co.'s Service, and was educated at the Edinburgh Academy. After a preliminary training in Edinburgh, he joined the London Stock Exchange, and after about twenty years he retired and came to reside in Edinburgh. He was greatly attracted by the study of natural history, and was a most assiduous collector. He devoted special attention to the genus *Carex*, and an exhaustive work by him on British sedges was in the press at the time of his death. He was at one time President of the Microscopical Society, and took great interest in the work of the Botanical Society, to which he frequently contributed.

The study of British birds was also one of his hobbies, and he possessed a very fine collection. He took great interest also in the study of shells, of which he possessed many beautiful examples. He was of a happy and enthusi-

astic temperament, and his breezy manner became contagious in any company. Genial and kind-hearted, and a lovable companion, his unexpected death in the very midst of his activities came with a shock of surprise to the many friends by whom he will be greatly missed.

JOHN ARCHIBALD, M.D., who became a Fellow in December 1866, died at his residence, "Hazelden," Bournemouth, on 23rd March 1908. He was also a Fellow of the Royal Society of Edinburgh, and a Fellow of the Royal Scottish Society of Arts.

WILLIAM SANDERSON, F.R.S.E., became a Fellow of the Society in 1882 and died at his residence, Talbot House, Ferry Road, Leith, on 4th April 1908. He was an example of a very busy commercial man who found leisure to interest himself in botanical science. He took a special interest in the cultivation of orchids, of which he exhibited some fine examples at meetings of the Society. He was also a Fellow of the Royal Society of Edinburgh, the Royal Scottish Society of Arts, and the Scottish Arboricultural Society.

GEORGETT WILSON BROWN, Victoria, British Columbia, became a non-resident Fellow in 1857. He appears to have become a Fellow at a time when he was brought into touch through lending some botanical drawings or paintings to the Society. For many years no communications had been received from him, and only recently word had been received of his death, which took place in May 1904.

WILLIAM PAXTON became a Fellow in July 1889, and died on 14th June 1907. He took great interest in the propagating of mistletoe, and introduced it in the garden at 11 Lauder Road, Edinburgh, in 1868. He also successfully introduced it at the Dean Cemetery, Edinburgh, and many plants of his introduction still flourish there. He also succeeded in flowering *Lilium giganteum* in the open at Lauder Road. He took a great interest in the cultivation of herbaceous plants, of which he had an intimate and encyclopædic knowledge, and he had gathered a very fine collection.

Professor D. CLOS, M.D., director of the Jardin des Plantes at Toulouse, and correspondent of the section of botany of the Paris Academy of Science, died in September 1908. He had been a corresponding member since 1865.

The President proceeded :—

I must ask you to excuse any formal address on the present occasion, owing to the pressure of official duties. It has been a great honour to me to fill the high office of President, and I desire gratefully to acknowledge the great kindness and consideration which I have uniformly experienced and the very loyal support given to me by the Council. I have especially to acknowledge my indebtedness to Professor Balfour for his unfailing courtesy and help. In my present dilemma I consulted him, and was encouraged to hope that the Society would overlook any shortcoming on my part in failing to give such an address as I should have felt incumbent upon me in ordinary circumstances. I desire also to acknowledge the admirable manner in which the business of the Society has been conducted by the Assistant Secretary, Mr. Jeffrey, from whom I have received invaluable and indispensable assistance.

THE BUCHAN FIELD CLUB AND REGIONAL RESEARCH.

An interesting event took place at Peterhead on the 10th October, the coming of age of the Buchan Field Club, founded in November 1887. It was celebrated by a large meeting in the Music Hall, Peterhead, and was attended by delegates from many learned Societies and other institutions, including the Royal Society of Edinburgh, the Botanical Society of Edinburgh, the Royal Physical Society, the Royal Scottish Geographical Society, the Senatus of the University of Aberdeen, Aberdeen Anatomical and Anthropological Society, the Society of Antiquaries of Scotland, the New Spalding Club, Aberdeen Philosophical Society, Edinburgh Geological Society, and many others.

The Botanical Society was invited to send a representative, and this duty was undertaken by one of our Life Fellows, Mr. Charles S. France of Aberdeen, who discharged his commission with conspicuous ability and to the great satisfaction of the Buchan Field Club.

It has been suggested to me that this event might have a little notice at this first meeting of our Society, and, indeed, it had already occurred to me to say something on the subject as a fitting part of that Presidential address which has been lying heavy on my conscience during the last few weeks.

Having been brought into rather intimate contact with the workers and the work of the Buchan Field Club, I have been greatly impressed by the high and permanent value of the work which the Club has already accomplished.

The objects of the Buchan Field Club are :—

1. The Study of Natural Science and of the Archæology, Folklore, History, and Literature of Buchan.

2. To interest the young in such studies.

3. To co-operate with the managers of the Arbuthnot Museum, Peterhead, for the improvement of that institution, which embraces the following departments :—1. Topography and Folklore ; 2. Antiquities ; 3. History ; 4. Biography and Literature ; 5. Geology and Mineralogy ; 6. Meteorology ; 7. Agriculture and Cattle Rearing ; 8. Botany ; 9. Zoology.

A glance at the nine portly volumes in which their twenty-one years' labours are recorded is most instructive. There are several notable articles in botanical science, the most conspicuous of which is a very exhaustive paper by Professor Trail of Aberdeen on "The Flora of Buchan: Its Distribution, Origin, and Relation to Man." It is a perfect example of what may be called "regional research," and is a model of what might well be done for other districts of Scotland by local workers.

I observe also that there is in preparation a majority volume in which the accumulated knowledge on all the points that come within the sphere of the Club's operations will be presented in a series of special articles each written by an accomplished expert in that particular department. In the department of natural science I see such names as Sir Arthur Mitchell, Professor Trail, Professor J. A. Thomson, R. N. Rudmose Brown, B.Sc., etc. This is to be written on popular lines, and cannot fail to be deeply interesting and stimulating to local workers as well as suggestive to workers elsewhere.

There are several Clubs of this kind in other parts.

One naturally thinks of the Berwickshire Naturalists' Field Club, which has done splendid work for many years. But there is ample room for more. This subject was touched upon in a most interesting way at the Dublin meeting of the British Association in September last in a paper by Professor H. A. Miers, F.R.S., in which he said, "One of the most useful functions of a body like a local society is to encourage a habit of expressing scientific results in simple and intelligible language that will appeal to the whole society. Indeed, nothing can be better or more useful for the scientific specialist himself than to attempt to explain his own work in simple language to a mixed audience."

In addition to this nothing is more wanted at the present day than books giving simple untechnical accounts of the living work by the worker himself, and this should be done not only in the newer fields of science, the popularisation of which is liable to be overdone, but in the more ordinary work of everyday science, which results in discoveries perhaps equally momentous, but at present buried beyond the reach of the amateur.

The educative work that the local societies can best perform through its members, who, though not children, have unprepared minds, is the encouragement of original research. This could be done, *first*, by inviting the trained and experienced workers to make known to them, through the medium of untechnical language, the beauty and interest of scientific work in the course of its progress, and of scientific discovery in the making; and *secondly*, by providing them with followers who will continue to prosecute, under their guidance, original observations and even experimental research. Enthusiasm has been instilled, and sincere students produced by the University extension movement; let the local societies initiate a new science extension movement by which the barrier between the professional man of science and the amateur, between the expert and the layman, will be broken down.

The Buchan Field Club impresses me as a fine example of a Territorial Association for the promotion of regional research, and their territory becomes a cosmos in the investigation of which the members qualify for work in the wide world anywhere. Mr Haldane's Territorial Army

Scheme was a splendid conception for the development of local patriotism and the association of men in the common aim of maintaining and defending our laws, our liberties, our homes, and our empire. But there are other fields for the development of patriotic action. Why not have a territorial army for regional research, a brotherhood of men of light and leading, for the attainment of a wider culture than is possible to isolated workers, a training and equipment for world-wide service? All honour to the men who give time and labour and thought to studying the art of war, and who are ready, if need be, to shed their blood at the call of duty. But no less honour to the men who give their days, and oftentimes their nights as well, to the building up of that intellectual enlightenment and culture which, after all, are more valuable and more enduring national assets than great armies or a fleet that secures the supremacy of the sea. He who can make two blades of grass grow where formerly there was only one, is a greater benefactor of his nation than the man who designs a ship of war superior to the latest *Dreadnought*. To add to the sum of human knowledge is a higher patriotism than to pile up implements of war. To unlock the treasure-house of nature and reveal the secret glories of the temple of science so that, with a fuller knowledge of his environment, man may better achieve the purpose of human life, is a worthier ambition than to be the inventor or expert manipulator of cunningly devised instruments of death. It was because I felt the Buchan Field Club, which might be widely copied, was such a Territorial Army of Regional Research for the furthering of this patriotic ambition that I, in the absence of any meetings of the Council, sent to them, as your President, by the hands of Mr. C. S. France, a letter of cordial congratulation from this Society on the celebration of their majority.

NOTE UPON SOME SEA-WEEDS FROM THE ISLAND OF DOMINICA,
BRITISH WEST INDIES. By Mr. SYMINGTON GRIEVE.

In January 1906, when in London, before starting upon a trip to the island of Dominica, I was asked by my friend Mr. E. M. Holmes to try and collect some sea-weeds there.

As most of my time was spent in the interior of the island, I unfortunately had little opportunity of visiting the sea-shore. However, once or twice when passing along or near the coast I made an effort to get a few specimens, especially such as were not too large to carry about with me. The result was only a collection of about twenty specimens, but of these, as far as I have been able to discover, none have hitherto been recorded from the island of Dominica. This encouraging fact has made me think it may be worth while recording this small collection. Mr. E. M. Holmes has been good enough to name the specimens, and he says several of them are interesting and rare. I am also indebted to him for the observations appearing in connection with several of the sea-weeds noted, under which appear his initials.

The *Sargassum* weeds will help to illustrate the distribution of that interesting family of sea-weeds, especially those in fructification. I have no doubt that another visit to the island would enable me greatly to add to my collection, as most of the likely places were too far out of the way for me to reach, and I had so much other work on hand.

The notes upon the distribution of the sea-weeds referred to in this list are mostly taken from the "Catalogue of the Marine Algæ of the West Indian Region," by George Murray, Esq., F.L.S., which appeared in the "Journal of Botany" for 1888, pp. 193, 237, 303, 331, 358, and for 1889, pp. 237, 257, 298; also some of my information I owe to De Toni, "*Sylloge Algarum*."

To Mr. E. M. Holmes, F.L.S., and the authors above mentioned, I desire to tender my best thanks.

ULVACEÆ.

Ulva fasciata, Delile.—Found growing upon rocks on sea-shore, Dominica, B.W.I.; Barbadoes, Dickie; Guadeloupe, Mazé; Gulf of Mexico, Schott.

Geographical distribution.—General in warm seas.

CLADOPHORACEÆ.

Chatomorpha antennina, Kütz.—From small rocks on the shore, North-east Dominica; Guadeloupe, Mazé.

Geographical distribution.—Indian Ocean and South Pacific.

Rhizoclonium arenosum, Kütz.—Found growing upon small outcrops of rock upon the seashore near Roseau, Dominica, B.W.I.

Rhizoclonium arenosum, var. *Occidentalis*, Kütz.—Found growing upon stones on the seashore near Roseau, Dominica, B.W.I.

Note.—This variety differs from the type, chiefly in the lesser diameter of the filaments, usually only half that of the type.—E. M. H.

SARGASSACEÆ.

Sargassum Filipelula, C. Ag.—Found growing upon small rocks upon the sea beach, Dominica, B.W.I.; Gulf of Mexico (*vide* J. G. Agardh); Florida, Melvill.

Sargassum platypterum, Mont.—Found growing upon small rocks upon the shore, Dominica, B.W.I.; Grenada, Murray; Barbadoes, Dickie; Guadeloupe, Mazé; Martinique, Duperrey; "Ad alias insulas Indiae Occidentalis" (Mus. Petropolit.), J. G. Ag.

Geographical distribution.—Warm Atlantic.

Sargassum pteroplicum, Grunow.—Found growing upon small rocks upon the sea beach, Dominica, B.W.I.; Bahamas, "Novara"; Florida, Palmer.

Sargassum vulgare, C. Ag.—Found growing upon small stones on the sandy beach, Portsmouth, Dominica, B.W.I.; Grenada, Murray; Barbadoes, Dickie; Guadeloupe, Mazé; Jamaica, Sloane, Chitty; Cuba, R. de la Sagra; Florida, Harvey, Melvill; Bermuda, Kemp, Rein.

Note.—The species of the genus *Sargassum* are almost impossible to determine with certainty in the absence of fructification, from the great similarity of the leaves or frondlets of species which have very different fructification. There is little doubt that extended observation would reveal other species on the shores of these islands, since twenty-five species are enumerated in the "Algues de Guadeloupe" as occurring in that island.—E. M. H.

DICTYOTACEÆ.

Haliseris delicatula, J. Ag.—Found growing on a few small rocks on the sandy beach, Portsmouth, Dominica, B.W.I.; Grenada, Murray; Barbadoes, Dickie; Guadeloupe, Mazé; Cuba, R. de la Sagra; shores of Mexico (*vide* J. G. Agardh).

Geographical distribution.—Brazil.

Note.—From its small size this species is easily overlooked when growing amongst other algae.—E. M. H.

Dictyota Bartayresiana, Lamour.—Found growing upon stones upon the seashore, Dominica, B.W.I.; Barbadoes, Dickie; Guadeloupe, Mazé; St. Thomas, Young; Danish West Indian Islands, Hohenack (Meeresalgen, Nos. 427, 428); Vera Cruz, Liebman; Florida, Melvill; Bermuda, Kemp; "Challenger."

Note.—This species bears considerable resemblance to several other species, and when sterile is recognised by the acuminate character of the young fronds and their subdivaricate branching.—E. M. H.

GIGARTINACEÆ.

Gymnogongrus tenuis, J. Ag.—Found growing upon rolled stones upon the seashore, Dominica, B.W.I.; Guadeloupe, Mazé; on the shores of the Mexican Republic, Liebman. Agardh gives it as Gulf of Mexico, and on the islands of St. Thomas and Martinique.

Gymnogongrus tenuis, J. Ag., var. *angusta*, J. Ag.—In this variety the branchlets are longer. Found growing on rolled stones upon the seashore, Dominica, B.W.I.

Note.—It is mentioned by Mazé and Schraum as occurring in four localities in Guadeloupe, but it has apparently not been noticed by many algologists, as it is comparatively rare in herbaria.—E. M. H.

Gymnogongrus tenuis, J. Ag., var. *brevifolia*, Holmes.—Growth: Spreading over the surface of rolled stones upon the sea beach, Dominica, B.W.I.

This variety has very short branchlets and does not appear to have been previously noticed.

Note.—The plant is evidently a very variable one, and further observation may show that these varieties are merely forms running one into the other.—E. M. H.

Acanthophora Thierii, Lamour?

Geographical distribution.—It is recorded from the shores of North America, West Indies, Mexico, Brazil, the Nicobar Islands, and Biarritz in Europe.

Note.—The specimen consisted of a fragment mixed with other algæ, and it was not possible to determine the species with certainty.—E. M. H.

RHODOMELACEÆ.

Laurencia tuberculosa, J. Ag.—Along with *Gymnogongrus tenuis* found growing upon stones upon the sea beach, Dominica, B.W.I.

CERAMIACEÆ.

Ceramiu clavulatum, C. Ag. (*Centroceras clavulatum*, Mont.)—Found growing upon rolled stones upon the sea-shore, Dominica, B.W.I. In Mr. George Murray's list in "Journal of Botany," at page 196, it is mentioned under the name *Centroceras clavulatum*, Ag., but De Toni, in the "Sylloge Algarum," regards *Centroceras* as a subgeneric group only.

The stations mentioned for this plant are:—Grenada, Murray; Guadeloupe, Mazé; St. Thomas, A. R. Young; Cuba, Hb. Montague; Florida, Harvey, Melville; Bermuda, Rein, "Challenger."

Note.—It is widely distributed in all the warmer seas, including the Mediterranean.—E. M. H.

GRATELOUPIACEÆ.

Grateloupia Cutlerie, Kütz.—Found growing upon rolled stones upon the sea beach, Dominica, B.W.I.; Guadeloupe, Mazé.

Geographical distribution.—Chili, Peru.

Grateloupia filicina, C. Ag.—Grenada, Murray; Guadeloupe, Mazé; St. Thomas, A. R. Young; Florida, Harvey.

Note.—Widely distributed in the warmer parts of the Atlantic and Pacific Oceans, and, like many of the species of the genus, variable in size and amount of division of the frond.—E. M. H.

Grateloupia filicina, C. Ag., var. *filiformis*, De Toni.—Found growing upon rocks upon the sea beach, covered at about half tide. Guadeloupe, Mazé; Hohenack (Meeresalgen, No. 380).

Grateloupia prolongata, J. Ag.—Found growing upon low rocks upon the sea beach, covered about half tide. Very near *G. filiformis*, but not distichous; proliferate from the surface of the frond; Guadeloupe, Mazé.

Geographical distribution. — Pacific and Indian Ocean.

Var. *cauda*, De Toni.

Note.—This differs from the type in its flagelliform branches.—E. M. H.

Grateloupia versicolor, J. Ag.—Found growing upon stones upon the sea beach about half tide. Dominica. B.W.I.

CORALLINACEÆ.

Amphiroa fragilissima, Lamour.—Found growing upon sea-weed from small rocks on the seashore. Dominica. B.W.I.

Geographical distribution. — Grenada. Murray; Guadeloupe, Mazé; Jamaica, Sloane; Florida, Harvey, Melville. Hooper; Bermuda, "Challenger"; also Mediterranean.

Note.—A brittle species with joints six to ten times, or even to fourteen times, longer than broad, and growing in cushions.—E. M. H.

Amphiroa breviarticulata, Aresch.—Dominica.

Geographical distribution.—West Indies.

Note.—In this species the joints are only two to five times longer than broad, and taper slightly towards the apex.—E. M. H.

EXCURSION OF THE SCOTTISH ALPINE BOTANICAL CLUB TO CRIANLARICH, 1908. By Mr. ALEXANDER COWAN.

The members left Edinburgh on Monday, 27th July, for Criannlarich Hotel, Perthshire, which was chosen as the headquarters, owing to the proprietor of the hotel at Tyndrum being unable to guarantee bedroom accommodation. On Tuesday, 28th July, it was hoped to visit Ben Lough, but as the mountain was largely enveloped in mist, it was thought better, after the members' experience on Ben Lawers in similar conditions a few years back, to wait for a more favourable day, and it was decided to take the morning train to Arrochar and walk from there along the shore of Loch Lomond to Ardlui, returning thence to Criannlarich by train in the evening. The day, fortunately, turned out very fine, but nothing of any great interest was found either on the roadside, on the shore of the loch, or on the higher ground visited by two of the members.

Carum verticillatum, a plant well known in this locality, was seen in large quantity. Besides this, the following plants were found:—*Blechnum Spicant* var. *anomalum*, *B. Spicant* var. *caudatum*, *Carex larigata*, *C. pallescens*, *Carum verticillatum*, *Circia alpina*, *Gnaphalium sylvestricum*, *Hypericum Androsaemum*, *Lastrea amula*, *Lythrum Salicaria*, *Lysimachia vulgaris*, *Polystichum aculeatum*, *Sanicula europaea*, *Scutellaria galericulata*. Leaves of *Quercus pedunculata* were gathered, one $10\frac{3}{4} \times 5\frac{5}{8}$, another $7 \times 6\frac{1}{8}$ ins.

As the morning of Wednesday, 29th July, was fine, it was decided to visit Ben Loagh. The members accordingly left Criandarich by the 10.5 train and alighted at Glen Lochy crossing, where it had been arranged that the train should stop specially for the convenience of the members, though this was about a mile short of the most convenient point on the line from which the ascent of the mountain could be made. The members spent the whole of the day on the various ledges of rock to the north of the mountain. Time did not permit of anyone getting so far as the corrie, or even as far as the best-known station for *Kobresia caricina*, and unfortunately no trace of this plant could be seen on the northern slopes of the mountain. The members, however, were fortunate in finding *Cystopteris montana* in considerable quantity on several ledges of the rocks, and a plant of the holly fern—*Polystichum Louchitii*—was found with all its fronds crested, doubtless a seedling either from the plant originally found there many years ago by Dr. Craig during a visit of the Club, or a seedling from a crested plant still growing on some inaccessible part of the rocks. As the railway authorities would not stop the evening train at Lochy crossing to pick up the members, the only alternative was for them to drive back to Tyndrum, and this entailed an early departure from the mountain. The day had fortunately kept fine, but as the members were walking homewards rain commenced to fall and continued without ceasing until they reached Tyndrum railway station, where the members were kept waiting a considerable time in their damp clothes, owing to the train being very late; fortunately, however, no one was any the worse of the unpleasant experience. The

following plants were found:—*Arabis petraea*, *Carduus heterophyllus* at 2000 feet, *Carex atrata*, *C. capillaris*, *C. dioica*, *C. flacca*, *C. pallescens*, *C. panicea*, *C. pilulifera*, *C. pulicaris*, *C. pulla*, *C. rigida*, *C. vaginata*, *Cystopteris montana*, *Dryas octopetala*, *Galium boreale*, *Geum rivale*, *Habenaria viridis*, *Juncus biglumis*, *J. castaneus*, *J. triglumis*, *J. triglumis*, *Salix herbacea*, *S. Muscicolas*, *Saxifraga alpina*, *Saxifraga aizoides*, *S. hypnoides*, *S. nivalis*, *S. oppositifolia*, *S. stellaris*, *Tofieldia palustris*, *Trollius europæus*, *Polystichum Lonchitis*, also *P. Lonchitis* var. *eristatum*.

One member of the party, who only arrived on Tuesday, found *Utricularia minor* in Loch Dochart. On Thursday the 30th July the members spent the day on Ben Alder. A considerable amount of time was spent in looking for *Carex irrigua*, as it was understood to have been found here by a late member of the Club some years ago, but no trace of it was seen. The ground was well stocked with sheep, and most of the herbage was well eaten down. The day was fine and misty alternately, the mist usually being accompanied by a wetting rain, and the wind was very cold. No plant of any special note was found, though numerous well-known plants were gathered, as the following list shows:—*Aira alpina*, *A. caespitosa*, *A. vivipara*, *Asplenium viride*, *Carex binervis*, *C. dioica* (male and female), *C. pallescens*, *C. panicea*, *C. pilulifera*, *C. rigida*, *C. stellulata*, very abundant *Epilobium alpinum*, *Festuca ovina*, *F. vivipara*, *Galium boreale*, *Gnaphalium supinum*, *Juncus trifidus*, *J. triglumis*, *Lastrea dilatata* var. *laciniata*, *Lastrea montana* var. *truncata*, *Loiseleuria procumbens*, *Lycopodium alpinum*, *L. annotinum*, *L. clavatum*, *Orchis latifolia* var. *incarnata*, *Polystichum Lonchitis*, *Pseudathyrium alpestre*, *Rubus Chamemorus*, *R. saxatilis*, *Saxifraga aizoides*, *S. hypnoides*, *S. nivalis*, *S. oppositifolia*, *S. stellaris*, *Trollius europæus*, *Vaccinium uliginosum*. *Rumex sanguineus* was also found near Loch Dochart.

On Friday, 31st July, three of the members decided to again visit Ben Loagh in order to botanise on the north-eastern slopes of the mountain, which the members were unable to reach owing to want of time two days previously. They therefore drove from Crianlarich as far as Coinish

farm, from which they walked a distance to the corrie of about three miles. They were all of opinion that this was much the easiest way to reach the mountain, as there is a path the whole way from Tyndrum to within a mile of the corrie; and no doubt, if the Club visits this district on a future occasion, ponies could be obtained for the older members to ride on, which would make a day on the mountain very much easier than having to walk to the botanising ground from the road at Glen Lochy and back there again at night. Fortunately, one of the first plants found was *Kobresia caricina*. *Cystopteris montana* was also found, showing that it is largely distributed among the rocks on this mountain. The following plants were also found:—*Allosorus crispus*, *Arabis petraea*, *Bartsia alpina*, *Carex atrata*, *C. capillaris*, *C. dioica*, *C. panicea*, *C. pauciflora*, *C. pilulifera*, *C. pulicaris*, *C. pulla*, *C. rigida*, *Cherleria sedoides*, *Cystopteris fragilis* var. *dentata*, *C. montana*, *Dryas octopetala*, *Epilobium alpinum*, *Galium boreale*, *Hymenophyllum* var. (not ascertained) *Juncus biglumis*, *J. castaneus*, *Kobresia caricina*, *Melampyrum alpinum*, *Polystichum Lonchitis* (two or three varieties), *Pyrola rotundifolia*, *Saxifraga aizoides*, *S. aizoides* var. *aurantiaca*, *S. hypnoides*, *S. oppositifolia*, *S. nivalis*, *S. stellaris*, *Saussurea alpina*, *Silene acaulis*, *Tofieldia palustris*, *Vaccinium uliginosum*. The day was cold and misty, with a strong west wind.

The other members spent the day at Tyndrum, where *Loiseleuria procumbens* was gathered, but as the day was so stormy, fishing on Lochan Bhe was impossible, and it was with great difficulty that a few specimens of the supposed *Scirpus fluitans* were obtained.

The members returned home on Saturday, the 1st of August, having had on the whole a fairly interesting meeting. The weather, though warm in other parts of the country, was extremely cold in the evenings, and there was always continual mist on the higher mountains, accompanied by occasional showers of rain.

NAIAS FLEXILIS, ROSTK ET SCHMIDT, AS A BRITISH PLANT.
By ARTHUR BENNETT, F.L.S.

"On October the 11th, 1850, at a meeting of the Botanical Society of London, Mr. D. Oliver, junr. (now Emeritus Professor Oliver, LL.D., F.R.S.), exhibited specimens of *Naias flexilis*, Rostk. et Schmidt, discovered by him in a pond near Roundstone, Connemara, Ireland, in August last."¹ This was afterwards gathered by Mr. A. G. More and others in Lough Cregduff, which was supposed to be Mr. Oliver's station, although the distance did not quite agree.

In September 1877 Mr. A. G. More gathered it in Lough Caragh, S. Kerry, in 15 to 20 feet of water, associated with *Eriocaulon*, *Isoetes lacustris*, *Lobelia Dortmanna*, etc.²

In August 1885 it was found at Killarney, N. Kerry, by the Rev. E. F. Linton!. Gathered at Glencar 1899 and Killarney by Dr. Scully.

Gathered as lately as 1896 by Mr. Lloyd Praeger in Lough Cregduff.

In Scotland. "First found in Loch Cluny, Drummond Hay, 1872."³ But Col. Drummond Hay notes,⁴ on specimens sent by him, "the discovery of this plant by Mr. Sturrock of Blairgowrie in the summer of 1865 (a slip for 1875)." I am not able to explain this discrepancy. Messrs. Robb and Sturrock found it in Loch Cluny (157 feet above sea level) on 13th August 1875, "growing in water about 5 feet deep, generally along with *Callitriche autumnalis*, L., or a *Chara*, but sometimes in patches by itself."⁵

In Loch Cluny it is associated with *Sagittaria*, *Elatine hexandra*, *Callitriche hamulata* and *autumnalis*, *Lobelia Dortmanna*, *Littorella*, *Utricularia* sp., *Potamogeton natans*, *lucens* (?), *angustifolius* (Zizii), *perfoliatus*, *pratensis*, *crispus*, *pusillus*, *obtusifolius*, *heterophyllus*, *Sparanium minimum* (?), *Najas*, three species of aquatic

¹ "Phytol," iii. (1850), 1088.

² "Jour. of Botany," Nov. 1877, p. 350.

³ "Flora of Perth" (1898).

⁴ "Rep. Bot. Ex. Club," 1877-8, p. 10, 1879.

⁵ "Scott. Nat.," 199, 1876.

Ranunculi and *Nymphaea*. By the note on the *Utricularia* I should expect it to prove *U. neglecta*.

It was planted in Loch Lindores, Fifeshire, 23rd August 1878 by Dr. B. White and Col. Drummond-Hay. The specimens from Loch Cluny.¹

Afterwards "found in almost all the chain of lakes between Dunkeld and Blairgowrie."²

In Ochertyre Loch (S.S.E. of Doune), in Perthshire, by Dr. B. White, where it occurred with *Potamogeton lucens*, *perfoliatus* and *heterophyllus* (Dr. White sp.).

In July 1908 Mr. M. McNeill of Colonsay, Inner Hebrides, sent me a large box of a gathering with rake, etc., from Loch Fada in that isle. This loch is about 2 miles long and 124 feet above level of sea. Among the specimens I found several small masses of the *Naias*. It was associated with *Ranunculus Draculi*, *Elatine hexandra*, *Callitriche cataractalis* in abundance, *Myriophyllum alterniflorum*, *Utricularia minor* and *neglecta*, *Littorella*, *Spartanium minimum*, *Juncus supinus* var. *fluitans*, *Potamogeton heterophyllus*, *perfoliatus* and *pusillus*, *Chara aspera* and *fragilis*, and *Nitella opaca*. A later box received from Loch Sgoltaire did not contain the *Naias*, but had *Nitella translucens*, an addition to the island flora. It is probable the *Naias* will be found in other lochs in Western Scotland if they are "dragged." In the "Student's Flora," ed. ii., 1878, Sir J. D. Hooker gives "Skye" as a habitat for the *Naias*. I have not been able to ascertain on what grounds he does so. It is not so given by Dr. Traill in his Scottish Topographical Botany in "Ann. Scott. Nat. History," nor is it marked by Mr. Symers Macvicar in a London catalogue of Skye plants which he kindly sent me.

All the Scottish and Irish specimens I have seen fairly agree with the American plant, but in Lake Ringsjön in Scania, Sweden, occurs the var. *microcarpa*, Nilsson, which is characterised by much smaller fruit. In Europe *glacialis* occurs in Sweden (Scania! and Upland!) in Pomerania, Marchia! Russia, prov. Olenetz and Borussia! Garcke. In N. America it is generally distributed in Canada and the United States, but does not reach the Southern States. In Finland it probably occurs in Lake Onega, but Hjelt, in

¹ "Scott. Nat.," v. (1879), 131.

² "Fl. Perth" (1898), p. 313.

his "Flora Fennica" (1895), 521, does not notice the *N. tenuissima*, Al. Braun, which certainly occurs in Finland, nor does Nyman in his "Consp. Fl. Europ." (1882), 685. This was named *N. minor*, All., var. *tenuissima* by Braun in "Jour. of Botany" (1864), 277, but Magnus, in "Beit. Kent. Gat. Najas" (1870) 24, 45, made it a species, and Dr. Rendle in "Trans. Linn. Soc." (Botany), v. (1899), 414, does the same. I have one of the original specimens gathered by Norrlin¹ in the Vesijari-see, but he placed it under *N. fragilis*, Del. = *N. minor*, All. Norrlin² gives as a locality for *flerilis* "Savenshiji ad Velikaji-guba." This is in 62° 15' N. lat., at the northern end of Lake Onega.

N. flerilis has occurred in recent beds in a fossil state in Hanover, Holstein, S.W. Norway, Sweden, and E. Finland (Rendle, *l.c.*)

In England in pre-Glacial beds at Paketfield in Suffolk, *N. marina*, L., and *N. minor*, All., have occurred, but Mr. C. Reid³ does not mention the occurrence of *N. flerilis*.

ATRIPLEX CALOTHECA, FRIES, AS A SCOTTISH SPECIES.

By ARTHUR BENNETT, F.L.S.

For some years I have been expecting to see specimens of the above species from some of the northern counties of Great Britain. But the want of complete specimens with good fruit has compelled me to hesitate in applying the name to many specimens. Fries adapted the name from the *A. hastata*, L., γ *calotheca*, Rafn., "Damn. Fl.," ii. 240, 1796, and published specimens of it in his "Herb. Norm.," viii., No. 84 (1841): describing it in his "Nov. Fl. Suec.," Mant. 3, 164 (1842):—

"*A. calotheca*, herbacea, patulo-ramosa, subprostrata foliis triangulari-sagittatis sinuato-dentatis, supremis interriginis, floribus terminalibus spicatis, calycibus femineis triangularibus, in dentes acuminatos subulatosve laciniatis." (Fries, *l.c.*)

It has been divided by various authors in various ways.

¹ "Bid. Syd. Tavastlands Flora" (1871), 126.

² "Fl. Karl. Onegensis," 1 (1871-4).

³ "The pre-Glacial Flora of Britain," Jour. Linn. Soc. (Botany), vol. xxxviii. (1908), 211.

Westerlund, author of a critical account¹ of the Swedish Atriplices, did not take up some earlier names, and so confused the synonymy. Richter, "Pl. Europ.," ii. 144 (1897) gives—

a. the type.

β. macrotheca, Mog. (1849).

γ. stipitatum, Hartm. (1879)

δ. pedicellatum, Marss. (1869).

ε. patrifolium, Lange (1864, not 1886, as Richter gives).

In the latest "Swedish Flora," Neuman and Ahlf., 569 (1901), is given a var. *tenacibracteatum* which seems scarcely different to Westerlund's var. *macrotheca*.

The distribution of the species is:—

Norway (Christiania), Sweden, Denmark, Finland, North Germany, Schleswig-Holstein, but is not given for the Faroes (Ostenfeld) or Holland (Vuyck).

It is given for six coast provinces of Sweden, but is doubtfully native in Finland.

So far as Scotland is concerned, the following, I believe, will prove to be this species, but are doubtful:—

? Shetland, Beeby, 11th August 1896, No. 1163.

? E. Sutherland, E. L. Marshall sp.

? E. Ross, E. L. Marshall, 20th July 1891, No. 97.

? Wigton, J. McAndrew sp.

The only specimens I can confidently name are those from the coast of Moidart, Argyllshire, gathered by Mr. Symers Macvicar, and sent to me a few years ago with a series of Atriplices from that and the neighbouring coasts. Remarks on the species will be found in "Ann. Scot. Nat. History," 33, 35, and 119 (1899).

A specimen of *A. littoralis*, L., gathered by Dr. Playfair, "15.9.1874, Abercorn (shore of Forth), Linlithgow, strongly simulates the var. *longipipes*, Drejer, "Fl. Hafn.," 107 (1838) of *A. calotheca*, and is, I believe, referable to *A. littoralis*, L., var. *γ angustissimus*, Marss., "Fl. Neu-Pommern," 394 (1869), found in Pomerania and Hungary.

The British Atriplices want a careful revision and collation with Continental specimens: it is one of the neglected genera, but requires, above all, good specimens in good fruit.

¹ "Bid. k  nn. Sveriges Atriplices Ak. Afl. Lund.," 1861.

AERIAL ROOTS OF ACANTHORHIZA ACULEATA. By Miss
BERTHA CHANDLER, M.A., B.Sc. (Plates I. and II.)

The development of aerial roots is by no means an uncommon occurrence among many plants. We find such plants as *Rhizophora*, *Monstera*, *Ficus*, *Delonix* and others producing these organs under normal conditions: and, indeed, most plants may be induced to form these structures under conditions of excessive heat and moisture.

Acanthorhiza aculeata, a palm, develops quite normally abundant aerial roots. They differ from normal aerial roots in the fact that at a certain stage of their development they lose their root-cap and become metamorphosed into hard woody structures, literally thorns. This curious fact about these roots was noticed as early as 1880 by Dr. Friedrich.¹ His examination was conducted almost entirely from the structural standpoint, for he deals with the development of tissues in these roots as they pass from normal aerial roots to thorns, and he touches very little on the physiology or function of these structures.

There are two specimens of this plant in the palm-house in the Royal Botanic Garden, Edinburgh. A photo of one of these by Mr. R. Adam, is given (Plate I.). These specimens were studied with the permission of the Regius Keeper, and the results of my examination have made it possible for me to revise Dr. Friedrich's paper, and to add a few further notes, together with figures which were not given by that author. He examined specimens in the Botanic Garden, St. Petersburg, and gives as an average length of a root about 10 cm. In the specimens in the Royal Botanic Garden, Edinburgh, some branched roots reach a length of 40-50 cm., though the unbranched roots rarely attain a length of more than 15 cm.

The external appearance of these aerial roots are readily seen from Plate I. They arise usually at the base of the leaves after the leaves have fallen away. The roots are to be seen in the figure developed roughly in rings round the trunk. Often they are developed, however, before this stage, and on tearing down the sheath covering the base of

¹ "Acta Horti Petropolitani," 1880.

the leaf a root can be seen flattened against the trunk. On emerging from the leaf-sheath they become cylindrical in form and branch freely. Some of these flattened roots can be seen in the centre of the figure lower down on the stem.

Three distinct stages may be noticed in the life-history of these aerial roots. The young roots emerge as soft green structures, provided with a root-cap. They lengthen, and the root-cap is loosened, hanging from the tip of the root and easily dislodged by artificial means. This constitutes the second stage in the metamorphosis of these roots. The final stage is reached when the root-cap is lost, and the root becomes completely hardened, forming a thorn.

These stages can all be distinctly seen in the figure. These constitute the changes for unbranched roots, and also for the longer branched roots, the lateral roots of which differ in no respect from the unbranched ones. There are many other aerial roots, however, especially at the base of the tree forming a dense interwoven thicket, which do not harden and become thorns, but, entering the ground, develop as normal roots, and perform much the same function as the prop-roots in *Pandanus*.

The internal features of these aerial roots have been so minutely described that there is very little to add. But a summary may be given of Dr. Friedrich's results, together with one or two interesting points that have been overlooked.

Looking at a longitudinal section of a young aerial root, and comparing it with a typical root-cap, say, for instance, that of barley, the difference will at once be noticed. In the latter case the loose cells are approximately the same size, and there is no differentiation into an outer and an inner root-cap as in the former (see Plate II. fig. 2). "The cells of the outer root-cap," to quote Dr. Friedrich, "are parenchymatous, and arranged in a brick-shaped manner one above the other: their walls are thickened, pitted, and markedly lignified (showing an intensive yellow coloration with aniline sulphate). Between them are distinct inter-cellular spaces. The inner root-cap is distinguished from the outer by the different shape of its cells, which are smaller, more polyhedral, parenchymatous cells formed by tangential division" (Plate II. figs. 2 and 3).

The epidermis is interesting. The cells are markedly thickened to the outside, at the point where they touch the root-cap, while the other sides of the walls remain unthickened (fig. 3, *a* and *b*). These epidermal cells are concave to the outside, but gradually take on a more regular, flat-shaped form. Owing to the direction in which the epidermal cells lie, a longitudinal section of the root shows a transverse view of the epidermal cells; a transverse section shows a longitudinal view of the cells. A special median section would show the epidermis as a layer quite distinct from the rest of the meristem tissue right to the apex, thus dividing the root-cap from the root itself. The cells of the epidermis increase through radial division, and the thickening of the outer part of the walls can be watched from very early stages upwards.

In the second stage of the life-history of these aerial roots internal changes have also taken place. In a longitudinal section the root-cap is seen to be only slightly adhering to the root (fig. 4). The outer thicker layer has noticeably peeled off in layers, forming the tufted mass round the root, which can easily be detected with the naked eye (fig. 1, *b*). The inner layer, too, gradually loosens from the epidermis, the cells of which become gradually thickened to the outside (fig. 4, *a*).

In the final or thorn stage the metamorphosis is complete; the root-cap, if present at all, is so loose that it is more like a thimble on the root, like the root-pocket of the Lemnaceæ, and can easily be detached leaving behind a bristle or thorn (fig. 1, *c*). The transverse sections of aerial roots at various stages in their life-history show more distinctly the process of hardening (figs. 5-9). The essential features shown in a transverse section are, the epidermis, the protective sheath (*Schützhülle*), consisting of thick cells (Dr. Friedrich says that he has observed this tissue in no other aerial root, but it is observable to some extent in palm pneumathodes, roots of Bromeliads, etc.), an outer cork tissue, an inner cork tissue with larger cells to the outside, small to the inside, a distinct endodermis, a typically palm vascular system xylem alternating with the phloem, and the pith. Transverse sections of the upper portion of the axis of the thorns show well-marked aerenchyma in the inner cortex. The figures

show that as the sections approach the tip of the thorn the wood tissue is considerably increased and the aerenchyma gradually lost (figs. 6, 7, 8). A section near the tip shows practically all hardened tissue except phloem. As Dr. Friedrich puts it, with the whole change of the aerial root into thorns nothing is altered in the anatomical arrangement of the inside tissues: the cells of all the tissues, with the exception of the phloem become thickened and lignified. The flattened bases of some of these aerial roots (fig. 9) exhibit the same essential features as the circular roots themselves, but with a much more marked woody development.

Mention was made of the roots which are found, on tearing down the leaf-sheath, flattening themselves against the trunk. The point is interesting, for they resemble in this respect the intracortical roots of the Bromeliaceæ; for example in *Puya* and *Kingia*. These roots, one will remember, are developed inside the cortex, and on emerging lose their root-cap, a further point of resemblance to a stage in the development of the aerial roots in *Acanthorhiza*. The flattened roots may be simply explained as the pressure of the leaf-sheaths, since on emerging they become cylindrical in form: but the striking resemblance in habit to the intracortical roots of the Bromeliads, and the tendency of the roots to lie parallel with the stem, suggests another cause, that of atavism, that is to say, that the memory of a former habit similar to the roots of the Bromeliads still clings to them.

The interesting point to notice about these aerial roots is their function: there is no doubt that in their early existence they function as pneumathodes or breathing roots, an inference drawn from the presence of much aerenchyma. This function persists even in the thorn stage, where aerenchyma are found at the base of the structures, but with the loss of the root-cap and aerenchyma the function becomes largely that of protection. The fact that many of these roots do not proceed as far as the thorn stage, but on entering the ground develop as normal roots adds a third function to those already mentioned—one similar to that of the prop-roots of the Pandanaceæ.

EXPLANATION OF PLATES.

PLATE I.

Photo of a specimen of *Acanthorhiza aculeata* at the Royal Botanic Garden, Edinburgh. (By Mr. Robt. Adam.)

PLATE II.

Fig. 1. Various stages in the life-history of aerial roots of *Acanthorhiza aculeata*.

- a.* youngest stage—root-cap firmly adhering.
- b.* 2nd stage—root-cap a loose tuft.
- c.* complete metamorphosis into a thorn.
- d.* a branched root.
- e.* an aerial root flattened in its upper portion.
- „ 2. L.S. of young aerial root.
 - a.* epidermis (thickened on outer walls).
 - b.* epidermis under the root-cap.
 - c.* inner root-cap.
 - d.* outer root-cap.
- „ 3. Enlarged portion of fig. 2. (Lettering as in fig. 2.)
- „ 4. L.S. of an older root showing the peeling off of both outer and inner root-caps in layers.
- „ 5. T.S. of the axis of a branched aerial root. A T.S. of the axis of an unbranched root (fig. 10, *a*) would be similar.
 - a.* epidermis.
 - b.* protective sheath (*Schützhülle*).
 - c.* outer cortex.
 - d.* inner cortex.
 - e.* endodermis.
 - f.* xylem tracheids.
 - g.* phloem.
 - h.* pith.
 - k.* aerenchyma with thickened cells at intervals.
- „ 6, 7, 8 (corresponding to figs. 10, *b*, *c*, *d*). Successive stages across metamorphosed aerial root showing loss of aerenchyma and hardening of tissue. (Lettering as in fig. 5).
- „ 9. T.S. across flattened base of aerial root. (Lettering as in fig. 5.)
 - k.* cortical aerenchyma.
 - l.* pith aerenchyma.



Photographed by R. M. ADAM.



NOTE ON THE SEPTA IN ROOT VESSELS OF BROMELIACEÆ.

By Rev. JAMES WATERSTON, B.D., B.Sc. (Plate III.)

In cutting transverse sections of the hypogeal roots of many of the Bromeliaceæ one discovers frequently lignified bars stretching across the lumina of the vasa. These are thickened portions of the terminations of the vascular elements. As these septa—for such they are till the cellulose membrane between the bars has broken down—generally run obliquely to the longitudinal axis of the root, one seldom finds them complete in a section of normal thickness. By taking sections a little thicker than usual one can note the nature of the pattern on the septum. Often this simply reproduces the thickening on the walls of the vasa. A common type, fig. 3, shows a series of parallel bars between which the original membrane has disappeared. Thus the lumen of the vas is at intervals crossed by a series of oblique gratings. Sometimes lignification goes further. The bars may be interconnected, and a somewhat reticulated septum results, fig. 4. Possibly owing to the strain being less, the original membrane may in such cases be preserved intact. Its presence can be demonstrated by staining with a suitable reagent.

Recently, in almost perfectly transverse sections from roots of *Puya* (three spp.), characteristic septa were noted. Their thickening does not copy that on the walls of the vas. It is broad and stout with few bars on each septum. The original membrane may persist, fig. 1, or may be ruptured, figs. 2, 5. This often takes place irregularly, but in one case (*P. chilensis*) it is very definite. A septum of this sort must exercise a particular, regulative effect on the passage of any fluid through the vas.

Doubtless also, when every trace of the cellulose membrane has gone, the struts of the septum will still be of considerable mechanical importance for the plant. In almost any root that would be the case. But it is an arrangement of special value for the Bromeliads. In this group the vasa are arranged in a peripheral zone round the thickened pith. Proximally they are embedded, it may be for fully two-thirds of their circumference, in a mass

of sclerenchyma, outwardly they are bounded by much weaker tissues—protoxylem, soft phloem, and wood parenchyma. The walls thus unequally supported must be better able to resist distortion, owing to the presence at intervals of these strengthening bars.

Good preparations of these septa can be obtained by immersing the sections for twenty-four hours in aniline-water-safranin, washing out with weak acid alcohol, and then counterstaining with aqueous methyl blue. If the washing out is checked at the right moment, the red and blue of the bars and septum respectively are pure and their contrast decided.

MORPHOLOGICAL CHANGES INDUCED IN ROOTS OF BROMELIACEÆ BY ATTACK OF HETERODERA SP. By Rev. JAMES WATERSTON, B.D., B.Sc. (Plates IV., V.)

The object of this communication—which cannot claim to be more than a preliminary notice—is to give a short account of changes induced in the various root tissues of the Bromeliaceæ by the presence there of a species of *Heterodera*. A more thorough examination has been made of the parasite's ravages in *Pitcairnia* and *Billbergia*, but, while the following observations were made on species of these genera, the attack is not confined to them.

Heterodera is a genus of the Tylenchidæ, a family of Nematode worms. Tylenchi, the stem-eel worms, are only too well known to agriculturists in Britain and elsewhere from their devastation of cereals. *Heterodera*, first recognised in the early sixties, shares this evil family reputation. *H. schachtii*, Schmdt., e.g. causes "beet-sickness," sometimes so severe that one-third of the crop (5) is destroyed. Like *Tylenchus* it attacks wheat (2), barley, etc. Cabbage (3) has also been injured. *H. radicicola* (4) was found in the Sahara to invade carrots, turnips, beets, tomatoes, the egg-plant (*Solanum Melongena*), onions, and celery.

It would be out of place to describe in detail the anatomy, etc., of *Heterodera*. But one or two points in its structure and life-history may be mentioned for an understanding of its characteristic attack.



1. *Pitcairnia cærulea*.
2. *Puya chilensis*.

3. *Puya* sp.

4. *Tillandsia Lescaillei*.
5. *Puya chilensis*.

The worm is well adapted to its specific life conditions (1). Both sexes have a strong mouth-prick, swollen proximally, by which the host's tissues are pierced and fixation there effected. When not exerted the style lies in a buccal groove immediately behind which is situated a bulbous muscular gizzard. This sucks in the juices of the host.

Marked sexual dimorphism occurs. The ♂, which when adult is recognisable by its six-rayed chitinous cap or "calotte," never loses its vermiform facies. But the ♀, which undergoes one ecdysis less than the ♂, and in fact retains its larval skin when adult, is greatly changed after impregnation. The reproductive organs and the alimentary tract become enormously swollen. Ultimately the worm is lemon- or citron-shaped. The genital pore from being lateral is shifted to a distinctly terminal position.

The larvæ of *Heterodera* are free living in the soil. At first they cannot be sexually distinguished. In some respects they resemble the adults, but differ in possessing pointed tails. After a time they attach themselves to the host plant, where the ♀ remains for life, falling off in the end either as an empty skin or as a brood-chamber for the young. The ♂ reaches maturity while attached to the plant. He then leaves it to find the ♀. Just before leaving he has assumed his peculiar head-dress. The larva is destitute of it; so too is the ♀, though in her case a covering of hardened sap simulates the "calotte" of the ♂.

Within the body of the gravid ♀ the embryos develop, and in their escape cause the death of their mother. The young may frequently be observed within a mucilaginous drop at the anal end of the parent. After hatching they make their way to the soil, where the life-cycle (four to five weeks) goes on as before. During the winter the unhatched larvæ of the last brood shelter in the skin of the dead mother.

Heterodera schachtii, Schmdt., does not penetrate at all deeply into the tissues of the plants attacked. *H. radicola*, and the form of which we are now speaking, on the contrary, live embedded in the host.

With respect to the former, the account of Vuillemin and Legrain (4) is here given without comment. These investigators found at El Oued (Sahara) that the majority

of the market-garden plants in cultivation were attacked. But the results were not uniform. Turnips and carrots were injured; beetroot, etc., thrive when *Heterodera* was present, but languished in its absence. In the latter case, in fact, only stunted, immature plants could be raised. This fact was at first regarded as a coincidence merely. Histological investigation showed, however, that the worm had brought about a useful modification of the tissues. Vuillemin and Legrain thus regard the association "comme une véritable symbiose." Further, they conclude, *Heterodera*, which in a moist¹ environment makes such havoc among root crops, produces most salutary effects in plants grown among arid desert sands. The injured carrots and turnips already referred to, at an early stage succeed in overcoming the parasite's beneficent action. Hence in their dry surroundings it becomes impossible for them to develop succulent tap roots. *Heterodera* has great resisting power to drought, and can lie dormant for a time. It thus proves a useful ally of the higher vegetation, "dans un milieu dont l'aridité exclut les symbioses cryptogamiques."²

The external symptom of the presence of *Heterodera* was a swelling of the root, spindle-shaped in Monocotyledons, round more or less in Dicotyledons. Transverse sections showed the following state of affairs:—In the vicinity of the worm, certain of the elements, both in the primary and in the secondary wood, were transformed at an early stage into greatly swollen "utricles."³ These bladder-like formations had collenchymatous walls with numerous water passages. The original cell had undergone division, without apparently formation of cell walls, till each "utricle" contained a multinucleated mass of protoplasm

¹ "Dans les serres ou dans les champs des contrées humides."

² For in the desert Leguminous plants when sown fail to produce mycodomatia on their roots.

³ The value of this modification depended entirely on the environment. At El Oued the garden soil, to a depth of 50 m., is nothing but sand. Twice a day the soil is liberally watered. Thanks to the structure induced by the parasite's attack, the plants take up sufficient liquid to last them in the interval. Turnips and carrots resist the formation of these giant multinucleated cells. The collenchymatous "utricle" in their case collapses at an early stage, or it is filled by a cell formation in which starch deposits. Thus though the roots may survive owing to their fleshy nature, they never become so succulent as others in which the attack has been successfully established.

rich in reserve nitrogenous matter and without starch. As the structures just described abut on the vasa, they were able to draw water thence, store it for a time, and then pass it on to the thirsty cells around them.

In the Bromeliaceæ the roots frequently show swellings near the tip. But in general the effects of the attack of *Heterodera* can best be seen in fusiform enlargements some distance back. These are inconspicuous until they have split open.¹

Rupture often takes place in the line of their long axis. The cortex is pierced. Sometimes even the vasa of the central cylinder are laid bare. Occasionally, with a lens, white specks in the innermost recesses of the fissure can be detected. These are, of course, the ♀ *Heterodera* swollen with eggs.

Now, because of the structure of the normal root, these ruptures setting aside the hypothesis of some mechanical disturbance, challenged investigation. In the Bromeliaceæ the root cortex shows in its middle a sheath of exceedingly hard sclerenchyma (Plate V. fig. 1). Section cutting is often a matter of great difficulty. But wherever these white specks could be made out, the sheath had evidently been pierced by some agent. Transverse sections showed an even more remarkable state of affairs, viz. that the sheath appeared never to have formed at the spots referred to. On one side of the section the thickened libriform sclerenchyma was replaced by a mass of thin-walled cells.

The following is a general account of the changes observed:—

In some extreme cases the whole of the central cylinder with the inner cortex had perished. The root was reduced to a sheath of sclerenchyma surrounded by the dried remains of the outer cortex. Occasionally traces of the piliferous layer could be distinguished. More often every indication of it had vanished.

Where the destructive process had not gone so far the surviving tissues showed more or less disorganisation.

¹ The swellings at the tip have been investigated without, however, yielding any data that cannot better be taken from the second point of attack.

- (a) The pith, whose cells are, as a rule, wholly lignified, peripherally at least, was scarcely abnormal. The thickening¹ was hardly so pronounced as usual. Its outline might be distorted. It has, however, never been observed to be invaded by the parasite.
- (b) In the Bromeliaceæ the vasa of the main roots are symmetrically ranged about the pith. *Heterodera* often occurs in the vasa where these are large, as e.g., in *Pitcairnia* spp. In some instances the parasites, dissected out from this position, were found to have attached themselves to the wall next the pith.

Where the worm is established the walls of the vas and those of the neighbouring wood parenchyma remain thin (Plate IV. fig. 5). Sometimes they are found broken down—thus preparing the way for the condition first described.

- (c) The phloem seems seldom to be invaded. But in the vicinity of an attack it may share in the hypertrophy induced (Plate IV. fig. 2, *ph.*).
- (d) The protoxylem may afford the parasite lodging and be obliterated. But even if the attack be only near a patch of protoxylem there may be marked increase in the size and number of the elements, e.g. a species with normally three small vessels has shown as many as seven or eight (Plate IV. fig. 3).
- (e) Generally *Heterodera* is found lying in a gall (Plate V. figs. 2, 3), whose long axis is roughly in a plane at right angles to the long axis of the root. Occasionally it may be placed otherwise—even parallel to the root axis. The gall itself is apparently formed from the innermost layer of the inner cortex, the endoderm, and the pericycle. Its walls consist of one or two layers of compressed cells which have been flattened against one another by the growth of the parasite.

Of the creature as found little can be said. Only the ♀ has been noted. Doubtless the ♂ and larvæ will be found when searched for in the soil. The ♀♀ occur commonly

¹ In one instance, however (Pl. IV., fig. 4), the pith consisted almost entirely of parenchyma.

in a large number of Bromeliaceae in cultivation in the Royal Botanic Garden, Edinburgh. Plants from the Botanic Garden, Glasgow, also show the same attack.

No anatomical details can, as a rule, be made out in these $\pm$. Practically all examined have been in the last stage—nothing more than sacs of eggs or more or less empty skins containing some protoplasmic debris. Occasionally large nuclei may be seen—apparently the last traces of the alimentary canal. A section of the creature's attack in a vas thus often shows merely a clear thick zone lining the cavity. Within there is a film of protoplasmic matter (Plate IV, fig. 5). The clear zone referred to is, of course, the thick and practically unstainable epidermis characteristic of Nematodes.

I do not know of any measurements made in the case of *H. schachtii* and *H. radicicola*. The present attack may be the work of a distinct species or even of more than one species, should the form infesting plants in the Royal Botanic Garden, Edinburgh, prove to be different from that found in Glasgow. The following dimensions may be given:—

	Length.	Breadth.
1. Adult ♀ from <i>Pitcairnia</i> sp. (lemon-shaped). Edinburgh .	·588 mm.	·35 mm.
2. Much younger ♀ from <i>Pitcairnia</i> sp. (shaped like a Florence flask) (This example began to narrow at a point ·21 mm. from the genital aperture. It there measured ·07 mm. in breadth.)	·448 mm.	·168 mm.
3. Eggs of ♀ No. 1, still in the body of the mother . . .	·084 mm.	·028 mm.

Satisfactory measurements of the endodermal galls have not yet been obtained for all three dimensions. In a number of sections taken from a root of *Pitcairnia bracteata* (Glasgow Botanic Garden) the length of the gall is ·252 mm. and the breadth ·112 mm.

In a gall from an Edinburgh plant (*P. corallina*) the transverse measurements are ·254 and ·112 mm. respectively. The length cannot be determined.

The worm then, one would imagine, must be under pressure. Apparently, too, it may be folded on itself within the gall, but details are not easily made out.

Changes in the tissue near the gall have now to be described.

Very characteristic are the effects on the endodermis

itself. Sometimes all trace of this in the immediate vicinity is lost. But, as a rule, it persists with the radial walls slightly elongated where the cells abut on the point of attack. For some distance on either side of the gall the radial walls of the endoderm are unthickened. Further round the normal thickening reappears. Thus an attacked root in T.S. shows an endodermis consisting on one side of thin parenchyma, on the other are the usual horseshoe-shaped cells (Plate IV. fig. 2).

The pericycle, under the irritation of *Heterodera* divides tangentially (Plate IV. figs. 2, 3, pp.) and may form a layer three to four cells deep.

The effect on the cortex too is distinct. In T.S. there appears a broad proliferation of thin-walled cells stretching outwards from the endodermis and widening as it goes. This mass of cells must originate from the inner cortex while that is still capable of division. The sheath of sclerenchyma, which forms in Bromeliads a mid-cortical layer, never is found opposite a gall (Plate V. figs. 2-4). *Heterodera* in some way inhibits the deposition of thickening matter on the cell wall. Two advantages in all probability directly follow. There is reduced pressure, while additional moisture may come in from the outside. Further, as rupture takes place latterly in this proliferated region the young *Heterodera* find prepared a passage to the soil where the early stage of the life-cycle is passed.

One curious feature of this mass of thin-walled cells is that here and there in it occur isolated elements over which *Heterodera* has had no inhibiting influence (Plate V. fig. 2). They are more or less completely lignified. Where the unthickened tissue joins the sheath there is frequently a gradual transition from such isolated cells to a broad continuous band of sclerenchyma. In other cases the line of demarcation is sharp.

As regards the final result of the attack, it has already been remarked that in extreme cases the entire central portion of the root is killed below the point of the worm's lodgment. In many instances—where the attack has been severe—the cells of the tissue a little above the parasite have been thickened or filled up. But as this condition is frequently observed in old normal roots

or where there has been mechanical injury, one can have no confidence in connecting it directly with the presence of *Heterodera*.

In one instance, however, the root had apparently reacted successfully against the worm. T.S. showed a triangular gaping wound reaching almost to the pith. In this space presumably the worm had been situated. Inside the thickened sheath a second, much narrower than the first, had formed. Opposite the wound this new sheath bent inwards, traversing the inner cortex, endodermis, etc., and effectually cutting off the injured area. About one-third of the functional central cylinder was thus saved. In the portion cut off the cells were either lignified or filled with gum, while the soft tissue which had caused the gap seem to have been suberised.

The nature of the tissue made no difference to its fate, cortex, endoderm, pericycle, phloem, and vasa were alike filled up.

There are some interesting points in a comparison of the present attack with that noted by MM. Vuillemin and Legrain. The Bromeliaceae are epiphytes and xerophytes in tropical America. Their environment, therefore, is in some respects comparable to that of the plants grown at El Oued in the Sahara. In both cases the parasite is internal and causes hypertrophy of the tissues. There is, however, nothing in the cell proliferation noted in the Bromeliads analogous to the "utricles" of V. and L., with their multinuclear protoplasmic contents, which are supposed to benefit the host. So far as the Bromeliaceae are concerned, it is extremely unlikely that at any time *Heterodera* comes under this beneficent category. Conceivably at the first it may stimulate the root tip to greater activity and cause a more copious water-supply. But for this there is at present no evidence. Everything points to the association of worm and root as one of malignant parasitism.

I have to thank warmly the following gentlemen:—

Professor Bayley Balfour, who has provided every facility for investigating the Bromeliaceae under his charge in the Royal Botanic Garden, Edinburgh. Mr. L. Stewart has also assisted in many ways. I am indebted also to the Glasgow

authorities and to Mr. Rourke, superintendent of the gardens there, for some valuable material.

Mr. W. E. Evans, B.Sc., very kindly made slides from sections illustrating the attack.

To my friend Dr. Ashworth I have been greatly obliged throughout. He has helped me in the identifying of the parasite, in searching for literature, by several discussions, and by the loan of slides of the life-history of *H. schachtlii*, Schmidt., which were shown to the Society when this communication was first read.

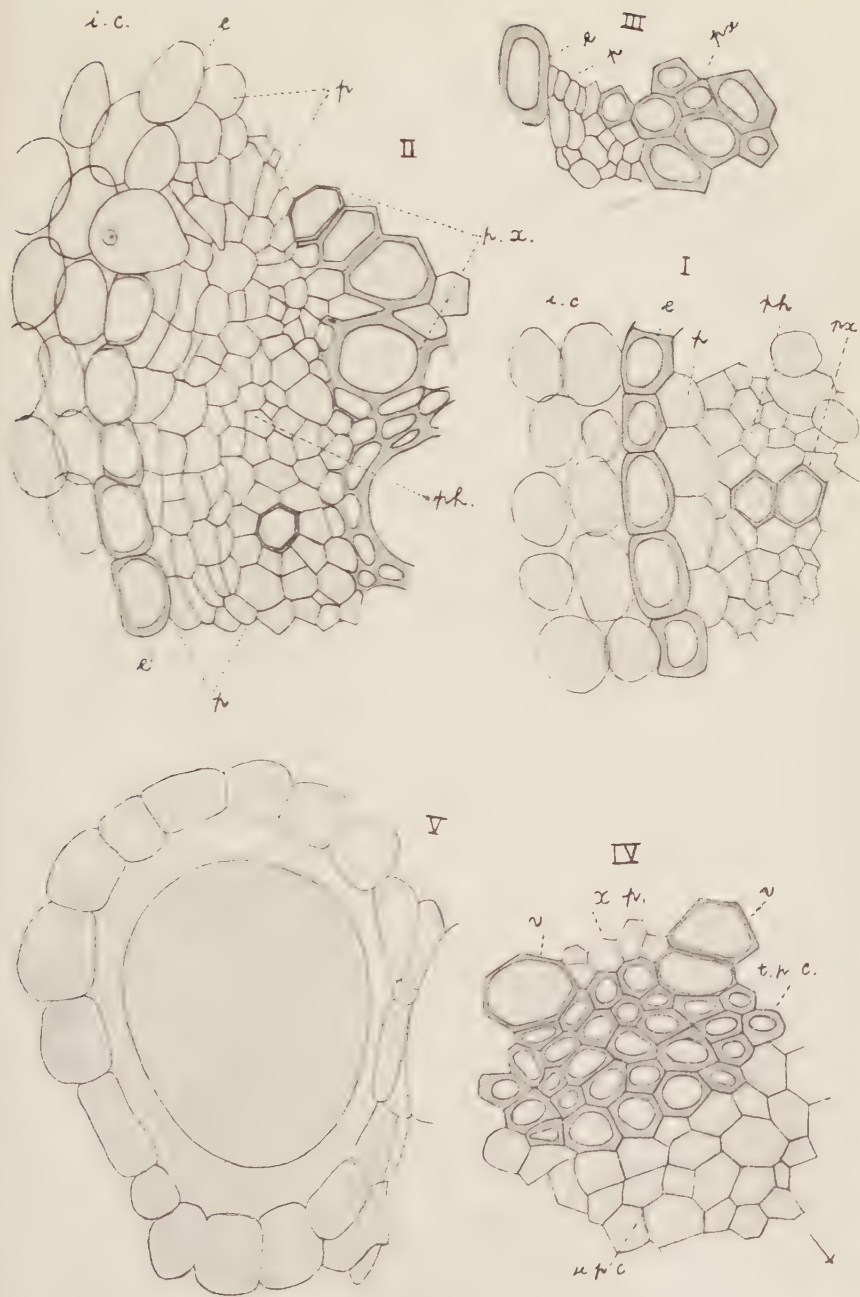
REFERENCES.

- (1) Drs. LEUCKART and NITSCHKE, *Erklärungen zu den zool. Wandtaf.*, Cassel, 1877.
- (2) C. CLAUS, *Traité de Zoologie*, 12th French edition. Ed. by Moquin-Tandon, Paris, 1884, p. 527.
- (3) SEDGWICK'S *Student's Text-Book of Zool.*, vol. i., London, 1898, p. 290.
- (4) VUILLEMIN et LEGRAIN, "Symbiose de l'*Heterodera radicola* avec les plantes cultivées au Sahara," C. R. Acad. Sc., cxviii., 1894, p. 549.
- (5) *Cambridge Nat. Hist.*, vol. ii. pp. 154-156.

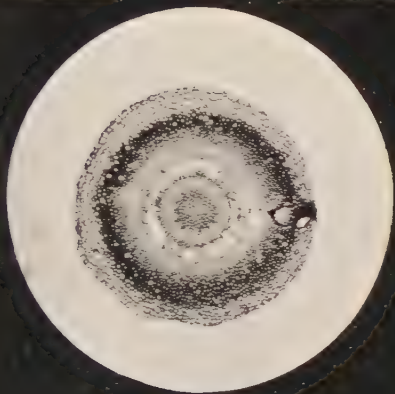
EXPLANATION OF PLATES.

PLATE IV.

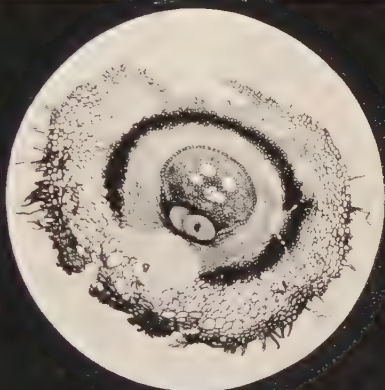
- Fig. 1. T.S. of Normal Bromeliad root, near endodermis. *Billergeria pallidiflora*.
- .. 2. T.S. of root (from large vas to inner cortex) near attack of *Heterodera* sp. *B. pallidiflora*.
- .. 3. Hypertrophied protoxylem. *B. pallidiflora*.
- .. 4. Pith and vasa. Thickening inhibited. *B. Saundersii*.
- .. 5. Attacked vas to show parenchymatous walls persistent. *Pitcairnia corallina*.
- | | |
|-------------------------------------|---------------------------------------|
| <i>i.c.</i> inner cortex. | <i>ph.</i> phloem. |
| <i>e.</i> endodermis. | <i>p.x.</i> protoxylem. |
| <i>p.</i> pericycle. | <i>v.</i> vas. |
| <i>t.p.c.</i> thickened pith-cells. | <i>u.p.c.</i> unthickened pith-cells. |
| <i>x.p.</i> xylem parenchyma. | |



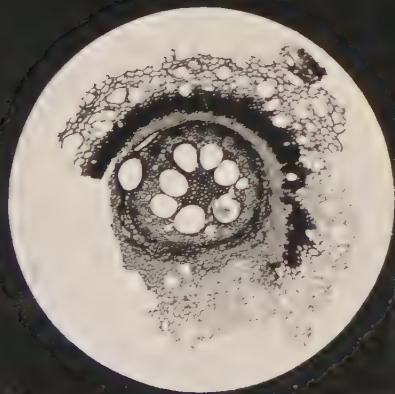
1



2



3



4

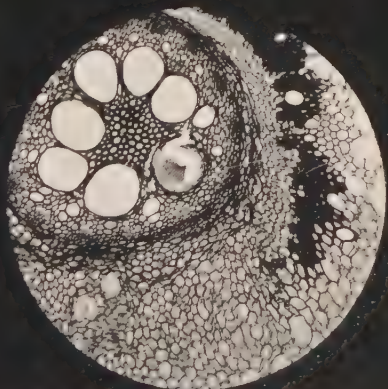


PLATE V.

Fig. 1. *Tillandsia dianthoidea*. T.S., a normal root. The lateral thin parts of the cortical sheath are due to the emergence there of secondary roots.

„ 2. *Pitcairnia bracteata*. *Heterodera* ♀ *in situ* in endodermal gall, apparently slightly doubled. Note the isolated thickened cell.

„ 3. *Pitcairnia corallina*, badly attacked root. The endodermis and vasa have been occupied.

„ 4. The same, more highly magnified.

EXUBERANT LENTICEL FORMATION ON AN OAK SEEDLING.

By Miss BERTHA CHANDLER, M.A., B.Sc. (Plate VI.)

At a former meeting of the Botanical Society Mr. Rutherford-Hill showed an oak seedling which had been sown in water, exhibiting, in consequence, abnormally developed lenticels on the roots. The specimen, which was eleven weeks old, was kindly given me by Mr. Rutherford-Hill, with another, seven weeks old. The photographs are from the former, the older specimen, which exhibited these outgrowths to a more marked extent than the latter.

Before examination under the microscope, these structures were thought to be "pneumathodes," but sections showed that they were rather lenticels having no differentiated structure apart from the lateral root which these encircled. The production of abnormal lenticels is very much akin to the artificial production of aerial roots, for the same factor, excess of moisture, favours the development of both structures. Just as pneumathodes can be induced in plants by cultivation under water, so abnormal lenticel formation, caused by the accelerated division of the lenticel initials, can also be induced. The oak seedling figured is an example. Terras,¹ speaking of abnormal lenticels occurring on stems, says that under similar conditions the same thing occurs on roots. The two main factors, the abundance of moisture and the reduction of the pressure owing to the slight resistance of the medium in which the seedling is grown, account for the abnormal development of these

¹ "Trans. Bot. Soc. Edin.," xxii. p. 450.

lenticels. The presence of the water has so accelerated cell division that two or more lenticels have cohered and formed the bell-like sheath around the lateral root.

EXPLANATION OF PLATE.

Fig. 1. Photograph of oak seedling, showing lenticels.

Fig. 2. Same, enlarged. *a, a*, exuberant lenticels; *b*, lateral rootlet.

Fig. 3. T.S. of root (median section) showing *a, a*, lenticels; *b*, lateral rootlet.

Fig. 4. L.S. showing *a, a*, lenticels; *b*, lateral rootlet.

Fig. 5. T.S. across root showing lenticel cut below a lateral rootlet. *a*, lenticel.

NOTES ON THE FLORA OF THE SCILLY ISLES.

By W. W. SMITH, M.A.

The first detailed account of the flora of the Scilly Isles is given by F. Townsend in the "Journal of Botany," vol. ii., 1864, pp. 102-120, where 348 species are recorded. The next addition is given by M. A. Lawson, 24 species, "Journal of Botany," 1870, vol. viii. pp. 357-358. In vol. xxxi., 1893, pp. 118-120, is a further list by A. Somerville giving 44 more, and in the same volume, pp. 265-267, 64 more, culled by E. D. Marquand from the unpublished papers of Ralfs on the Flora of West Cornwall. Ralfs visited the islands before Townsend, and the above 64 represent those in his original list which were not recorded in the above three communications.

The writer of this note visited the group in August 1906, and the twenty plants mentioned below are, I believe, new records. This makes a total for the islands of 500 species, of which 385 are Dicotyledons, 98 Monocotyledons, and 17 Filices.

Papaver somniferum, L.—Tresco. Occasional.

Crambe maritima, L.—Old Town shore, St. Mary's; Tresco, St. Agnes.

A Armoracia rusticana, L.—Tresco.

Brassica tenuifolia, DC.—Tresco. Rare.

Viola tricolor, L.—St. Mary's.

Viola tricolor, L., var. *arvensis*.—St. Mary's, St. Martin's.

Lychnis vespertina, Sibth.—St Agnes. Rare.

Medicago denticulata, Willd. —St. Mary's, Old Grimsby, Tresco.

Epilobium hirsutum, L.—Old Town marshes. Rare.

Carum Petroselinum, Benth.—Hugh Town, Tresco.

Caucalis Anthriscus, Huds.—Hugh Town.

Pieris ichioides, L. Roads about the Castle and Hugh Town.

Hieracium umbellatum, L.—St. Mary's.

Vinca major, L.—St. Mary's. No doubt an escape.

Verbascum nigrum, L.—Sandy flats in Tresco.

Scrophularia officinalis, L. Hugh Town, St. Martin's. Rare.

Veronica Buxbaumii, Ten.—St. Mary's.

Polygonum maritimum, L.—N. of Tresco.

Iris foetidissima, L.—Tresco dunes.

Phalaris canariensis, L.—Hugh Town, Tresco.

Most of the above species are probably introductions of late years. Conditions of cultivation have changed much since the trade in early spring flowers was started, and intercourse between the islands and the mainland has greatly improved.

The writer visited all five inhabited islands and a considerable number of the small rocky islets. Most corners were carefully examined and the conclusion come to that these lists represent pretty nearly the total possible in the group.

I am adding a few notes on some previously recorded species to supply localities omitted in previous records.

Glaucium luteum, Scop.—Shores near Hugh Town, Samson, Tresco, Bryher. Common and very luxuriant.

Nasturtium officinale, R. Br. —Not uncommon in the marshes of St Mary's.

Alyssum maritimum, L. Not uncommon in St. Mary's on the tops of old walls.

Silene maritima, With., is uncommon, but observed in several places on St. Mary's as well as on Samson—not on the shore, but on the cliff some distance from the sea.

Lavatera arborea, L., is very abundant on some of the

uninhabited islands such as Mincarlo, and seems to be indigenous.

Trifolium repens, L., var. *Tournefortii*, is still abundant in the old locality near the lake in Treseo.

Angelica sylvestris, L., was very luxuriant in marshes in St. Mary's, attaining nine feet.

Anthemis nobilis, L., is very common in the herbage in St. Mary's.

Sonchus arvensis, L.—Treseo, St. Mary's. Forms a conspicuous plant on the cliffs.

Samolus Valerandi, L.—Occasionally on the cliffs where there is slight accumulation of debris.

Plantago Coronopus, L., is very luxuriant on the shores, while *P. maritima* seems to be lacking.

Antirrhinum Orontium, L.—St. Mary's, St. Martin's, St. Agnes, Treseo.

Scrophularia Scorodonia, L.—St. Mary's, St. Martin's, Treseo, Samson, St. Agnes.

Briza minor, L.—Scattered by roadsides in St. Mary's.

Pteris aquilina, L., is the predominant plant in the uncultivated parts of the islands and is very luxuriant.

Here and there in the islands garden plants have established themselves such as species of *Mesembryanthemum*, *Geranium*, *Physalis*, *Muhlenbeckia*, while species of *Veronica*, *Euonymus*, and *Escallonia* form luxuriant hedges. St. Agnes is the reputed locality for *Acanthus mollis*, L. I failed to find it there, but saw two plants on St. Mary's, where in all probability they were escapes from cultivation.

TWEEDSIDE ALIEN PLANTS. By Miss IDA M. HAYWARD.

The Tweed district is specially rich in alien plants—a result due doubtless to the fact that the river and its tributaries flow through so many wool manufacturing towns. Seeds picked up in their native countries become detached from the wool in the process of washing. A considerable proportion find their way into the river and ultimately becoming lodged in congenial soil, take root and grow. Thus on deposits of alluvium and banks of shingle natives



Fig. 1

b

a



Fig. 2

a



Fig. 3

a
b

a

a
b
a



Fig. 4



Fig. 5

a

of Australia, New Zealand, and South America flourish together for some distance below the manufacturing towns. In favourable summers like that of last year some of these plants may be self-sown, but as a rule these aliens die down annually and the supply is kept up by the introduction of fresh seed. Possibly some may be naturalised in process of time. In any case it can hardly fail to be of interest to place on record a list of aliens recently found on the banks of the Tweed.

During last year the writer has collected frequently on the banks of the Tweed and its tributaries, on some occasions with the assistance of Mr. James Fraser. In all 139 spp. have been found: 9 are new to Britain—6 having already been exhibited¹ to the Society, while 3 have been noticed by Mr. Fraser in the "Annals of Scot. Nat. Hist." Jan. 1909, p. 40 ff. The others are included either in Druce's "List of British Plants," or in Dunn's "Alien Flora of Great Britain."

Below there is given a list of some previous notices of alien plants from Tweedside:—

1829. "Flora of Berwick-on-Tweed." Dr. Geo. Johnston. Includes 6 of the spp. now recorded.
1869. "Proc. Berwick Nat. Club." Stuart. 14 from Tweed and Gala.
1872. *Ibid.* "Tweedside Plants of Recent Introduction." Brotherton. (18.)
1876 *Ibid.* Rev. Jas. Farquharson, M.A., in "List of Flowering Plants and Ferns observed in Selkirkshire," gives 8 aliens.
1902. "Lauder and Lauderdale." Thomson. In the list of plants by Kelly and Shaw are 16 aliens.
1903. "Trans. Bot. Soc. Edin." Trail refers to 25 species.
1905. "Ann. Scot. Nat. Hist." Druce notes 5 near Melrose.

Of course the same plants figure often more than once in the above lists. After making all deductions, one finds that 68 of the species now enumerated have not been previously recorded from "Tweed."

For the identification of *Atriplex spongiosa*, F. von Muell, I am indebted to Professor Bayley Balfour, F.R.S., F.L.S. My best thanks are also due to Mr. James Fraser, who has gone over the ground with me on several occasions. I have also to thank the authorities of the Herbaria at Kew, South Kensington, and Cambridge, for determining some of the

¹ See Proceedings for 12th November of present issue (p. iii.).

rarer plants and for assistance rendered on the occasion of my visits last autumn to the collections under their charge.

Aconitum Napellus, L.—Several plants on Weirhill, Melrose.

Papaver dubium, L.—Several, Galafoot.

P. hybridum, L.—Near Galafoot, one plant growing by the river Tweed.

P. nudicaule, L.—Plentiful at Galafoot, on rubbish.

P. somniferum, L.—Several, on rubbish at Galafoot.

Arabis albida, Stev.—A colony at Galafoot.

Armoracia rusticana, L.—Several plants on bank of Tweed at north end of Suspension Bridge, Melrose.

Barbarea præcox, R. Br.—One plant at Galafoot.

Brassica alba, Boiss.—Several plants, Galafoot.

B. nigra, Koch.—Two or three, Galafoot.

Cheiranthus Cheiri, L.—Abbey walls, Melrose.

Hesperis matronalis, L.—A colony, Galafoot.

Lepidium Draba, L.—Galafoot, plentiful.

L. rudicale, L.—Galafoot, several.

L. sativum, L.—Abundant by sides of Gala and Tweed.

L. virginicum, L.—One or two plants, Galafoot.

Malcolmia maritima, R. Br.—One plant, Lindean.

Raphanus Raphanistrum, L.—Common, Galafoot.

Senebiera pinnatifida, DC.—Plentiful, Galafoot.

Sisymbrium orientale, L.—Abundant, Galafoot to Melrose.

Thlaspi arvense, L.—Common along the Tweed.

Lychnis Githago, Scop.—Several, Galafoot.

Silene gallica, L.—Two or three, Galafoot.

S. noctiflora, L.—Several, Galafoot.

S. rubella, L.—One plant, Galafoot.

Malva moschata, L.—One or two plants, Galafoot.

M. parviflora, L.—A single plant, Galafoot.

Linum usitatissimum, L.—Plentiful on shingle banks of Gala and Tweed.

L. perenne, L.—One or two plants, Tweedside.

Erodium moschatum, L'Hérit.—Two or three plants, Galafoot.

Medicago denticulata, Willd.—Very abundant, growing to large plants when well nourished, such as on wool

heaps, etc., and in gardens. To be found from Galafoot to the mouth of the Tweed.

M. leptocaulata, Willd. var.—On shingle, Tweedside, near Galafoot.

M. laciniata, Mill.—Plentiful, banks of Tweed.

M. maculata, Willd.—Common from Galafoot to Newstead.

M. minima, L.—On shingle banks of Gala and Tweed, plentiful, owing, no doubt, to the warm summer of 1908.

M. sativa, L.—Galafoot.

Melilotus alba, Desr.—Amongst grass above Galafoot, a single plant.

M. arvensis, Wallr.—One large shrub, bank of Gala.

M. indica, All.—A single plant at the mills, Gala.

Pisum sativum, L.—A few, Galafoot.

Trifolium angustifolium, L.—A single plant, Galafoot.

T. resupinatum, L.—Tweedside, on shingle, several.

Lythrum Hyssopifolia, L.—Plentiful from Galafoot to Newstead.

Ammi Visnaga, L.—Galafoot, one plant.

Caucalis leptophylla, L.—Two or three plants, bed of Gala and Tweedside.

Peucedanum Ostruthium, Koch.—Dryburgh, V.C. 80, been there since 1872; and Ettrick Bridge end, V.C. 79.

Valeriana pyrenaica, L.—Yair Bridge and Langlee Woods.

Dipsacus Fullonum, L.—Tweedside, several.

Bidens tripartita, L.—A single plant, Galafoot.

Calendula officinalis, L.—Several, Galafoot.

Calotis hispidula, F. Muell.—On banks of the Tweed, plentiful. A native of Australia.

**Cenia turbinata*, Pers., var. *concolor*.—A single plant, on shingle bed of Gala. It is a common weed through Cape Colony.

Carduus argentatus, L.—Several, Galafoot.

Centaurea Cyanus, L.—Several, Galafoot.

C. melitensis, L.—Very plentiful from Galafoot to Newstead.

C. solstitialis, L.—A single plant, Galafoot.

Cotula australis, Hook. f.—A single plant at Galafoot, gathered by Mr. Fraser.

C. coronopifolia, L.—A few specimens found on moist soil, Tweedside. Native of Australia, New Zealand, South Africa, extra tropical South America, and some parts of Europe, especially near the sea.

Doronicum Pardalianches, L.—Banks of the Yarrow, Duchess' Walk.

Erigeron acris, L.—Several, Galafoot.

Gnaphalium luteo-album, L.—One plant, Tweedside.

Guizotia abyssinica, Cass.—Plentiful, but scarcely flowers.

**Helipterum corymbiflorum*, Schlecht.—Tweedside. A native of Australia.

Hypochaeris glabra, L.—Plentiful, Galafoot.

Lactuca sativa, L.—Galafoot, several.

Madia sativa, Molina.—In several places from Galafoot to Melrose.

Matricaria Chamomilla, L.—Two plants, Galafoot.

M. inodora, L.—Several, Galafoot and along the Tweed.

Petasites fragrans, Presl.—A colony, Weirhill, Melrose.

**Senecio brachyglossus*, F. Muell.—Bed of the Gala, a few plants native of Australia.

**S. laetus*, Forst.—Banks of Gala and Tweed, plentiful. A native of Australia and New Zealand.

S. viscosus, L.—Common at Galafoot and all along the Tweed.

Solidago lanceolata, L.—Banks of Gala, several colonies.

Xanthium spinosum, L.—Abundant, Galafoot and along the banks of the Tweed, but did not flower.

Echinopsorium Lappula, Lehm. — A single plant, Galafoot.

Lithospermum arrense, L.—Several, Galafoot.

Lycopsis arrensis, L.—Several, near Melrose.

Lycopersicum esculentum, Mill.—Plentiful along the river banks.

Solanum Dulcamara, L.—Colony at mouth of Gala.

Linaria Cymbalaria, Mill.—Several, Galafoot.

L. vulgaris, Mill.—Plentiful, Galafoot.

Mimulus Langsdorffii, Donn.—Very abundant, almost from the source of Gala to its junction with Tweed.

M. guttatus, DC.—A large patch in Caddon below Clovenfords; one plant at Melrose.

Mentha viridis, L.—By the side of the Gala, a colony.

Hieracium hirsutum, L.—Galafoot and on mill wall, Galashiels.

Patagonchilus bonariensis, DC.—A single plant at Galafoot. Native of the Argentine.

Amaranthus Bicolor, L.—Banks of the Tweed, a few plants.

A. retrofractus, L.—Sides of Gala and Tweed, plentiful.

Atriplex patula, L.—Galafoot, several.

**A. spongiosa*, F. Muell.—Growing plentifully at the junction of the Gala and the Tweed. The berry-like spongy fruit is the interesting part of this plant. A native of Australia.

Cleomepidium ambrosioides, L.—A single plant in the bed of the Gala.

C. rubrum, L.—Several, Galafoot.

Fagopyrum esculentum, Moench.—A single plant, Galafoot.

Polygonum lapathifolium, L.—Plentiful, Galafoot.

**Rumex Brownii*, Campd.—Growing plentifully between Galafoot and Melrose.

Euphorbia Esula, L.—A colony, stone bridge above Melrose.

Cannabis sativa, L.—Mouth of the Gala and along the river Tweed; a few plants here and there.

Agrostis retrofracta, Willd.—On shingle between Galafoot and Melrose. An Australian grass, identified for Mr. Fraser by Professor Hackel.

A. verticillata, Vill.—Galafoot: a single plant, verified by Professor Hackel for Mr. Fraser.

Apera Spiraeocaulis, Beauv.—Plentiful between Galafoot and Melrose.

Avena fatua, L.—Several, Galafoot and Melrose.

Briza minor, L.—A single plant, Galafoot.

Bromus hordeaceus, var. *molliformis*, Lloyd.—Several at Galafoot.

B. macrostachys, Desf.—One plant, Galafoot.

B. madritensis, L.—Two or three plants, Galafoot.

B. patulus, Mert. et Koch (*B. japonicus*, Thunberg).—Several, Galafoot.

B. rigidus, Roth.—One plant, Galafoot.

B. secalinus, L.—Several, Galafoot.

B. tectorum, L.—One or two plants, Galafoot.

B. unioloides, H. B. et K. —Several, Galafoot and Melrose.

Brachypodium distachyum, Beauv. —One plant gathered by Mr. Fraser.

Festuca Agropyros, Linn.—Plentiful from Galafoot to near Melrose.

F. ambigua, Le Gall.—Several at Galafoot.

F. sciuroides, Roth.—Plentiful, Galafoot.

Hordeum murinum, Huds. —Plentiful, Galafoot and near Melrose.

H. murinum, L.—Plentiful, Galafoot and near Melrose.

H. vulgare, L.—Common along the river.

Koeleria phleoides, Pers.—Several from Galafoot to Newstead.

Lamarkia aurea, Moench.—Several at Galafoot and above Melrose.

Lepturus incurvatus, Trin.—Tweedside above Melrose, one clump, gathered by Mr. Fraser.

Lolium italicum, A. Br.—Common along the river.

Phalaris canariensis, L.—Several at Galafoot.

P. minor, Retz.—Two or three plants at Galafoot.

Polypogon maritimus, Willd.—On shingle, side of Gala, one or two plants.

P. monspeliensis, Desf.—Sides of Gala and Tweed, plentiful.

Secale cereale, L.—A few plants, Galafoot.

TRANSACTIONS
OF THE
BOTANICAL SOCIETY OF EDINBURGH.

SESSION LXXIV.

PRESIDENTIAL ADDRESS.

LADIES AND GENTLEMEN.—In taking the chair this afternoon, I wish to express to you my very great regret that I should come to you with an apology for my having been unable to embody in my remarks, in opening the meetings of the Society for the year, any subject of scientific and botanical interest, but I have found that pressure of other matters has made that quite impossible for an amateur like myself, and though deeply interested in the work of the Society, I cannot pretend to take place along with those who from time to time submit communications for our consideration and discussion.

I must therefore content myself with, and ask you to pardon, the restriction of this address to a general statement of the position of the Society, and to our customary reference to those Fellows and Members of the Society who, during the year, have passed away. I am sorry to say that our membership shows some reduction. As the Society now stands we have: 5 British Honorary Fellows; 25 Foreign Honorary Fellows; 109 Resident Fellows; 43 Non-Resident Fellows; 53 Corresponding Members; 9 Associates; 6 Lady Members—making a total of 250 Members of the Society.

These 250, for the purpose of consideration as representing possible active membership, must be analysed. I

find that all our Honorary Fellows, all our Corresponding Members, and nearly 70 of our Resident and non-Resident Fellows are either abroad or in England or resident at such distances from us here that they cannot be on what I might call the effective list, and we are left with about 100 others, many residing in the country districts, more or less able to attend our meetings and to take part in our work—a comparatively small number for a Society such as this, and a number I would like to see largely increased, especially in these days when there is so much general interest in botanical matters. During the year we have lost by death: 1 British Honorary Fellow; 3 Resident Fellows; 3 Non-Resident Fellows; 3 Corresponding Members; and by resignation 1 Resident Fellow, while we have added during the year 7 Resident Fellows and 1 Non-Resident Fellow. You will thus see that the Society's numbers are reduced by three as compared with last year.

Turning now to what should be communicated to you regarding those members who have passed away, I would first mention, as an outstanding name, that of the late Sir GEORGE KING, K.C.I.E., LL.D., F.R.S., who died at San Remo in February last, at the age of sixty-nine. He was elected an Honorary Fellow of the Society in 1895. Sir George King was an Aberdeenshire man, born there on 12th April 1840. He was educated at the Grammar School and at the University of Aberdeen. He studied medicine, and graduated in 1865 with the highest academical honours.

Botany had always been his favourite study, and he became for a time the assistant to Professor Dickie, the then Professor of Botany at Aberdeen University. Influenced by the advice of his academic friends at Aberdeen, he resolved to enter the Indian Medical Service. He studied at Netley, and in due time was posted to the Bengal Presidency. It is of interest to know that he was entrusted by Sir William Hooker to convey to India the first ipecacuanha to arrive in that country. This he cared for on the then much longer and more difficult voyage than now, and he handed it over in safety to the Calcutta Gardens in March 1866.

After a certain amount of medical service in India, his qualifications led to his being deputed to act temporarily

as superintendent of the Botanic Gardens at Saharanp ur in the North-West Provinces—no doubt much more congenial work.—and from this he passed to the Indian Forest Service. Then in 1871 the superintendentship of the Royal Botanic Gardens at Calcutta, and of the Indian Government's cinchona-planting experiments in Bengal, as well as the professorship of botany in the Medical College at Calcutta, fell vacant, and Dr. King was appointed to these offices. It was no light duty that had been placed in his hands. Cyclones of earlier years had reduced the gardens at Calcutta to a most dilapidated condition, and the Government's cinchona plantations had been but a doubtful experiment. The beneficent Government of India, however, made funds available to Dr. King, and in a comparatively short time the work of a master-hand was seen. The gardens were restored and remodelled, glass-houses, palm-house, and herbarium buildings were provided, and the gardens began to possess all the charm and efficiency for which they are now so justly famed. In a similarly successful way Dr. King tackled the difficulties which had attended the cultivation of the cinchona, and by his skill and administrative ability he enabled the Indian Government to provide for India, and to place within the reach of the poorest natives the necessary remedies obtainable from the cinchona bark. In 1876 Dr. King published a manual of cinchona cultivation in India, and this is the standard work on the subject.

Besides the work of these years—no light task—Dr. King was able to do much valuable botanical work, assisting Sir Joseph Hooker with voluminous material for his work on the flora of British India. In later years, when leisure was more easily got, Dr. King published important contributions to botanical literature. Largely through the liberality of the Government of Bengal, he was enabled to commence the "Journal of the Calcutta Botanic Gardens," which has contained numerous contributions from his pen. Monographs were published, including that of the now notably commercially and financially important genus of *Ficus*, and also other important genera of plants, most of those being of economic importance. At the same time he

made extensive studies of the vegetation of the Malay Peninsula. The "Kew Bulletin" of May 1909 gives a list of no fewer than sixty-three works published by the late Sir George King, many of them not only of great importance, but of a nature that must have involved an immense expenditure of labour and time as well as of scientific research.

In 1891 Sir George King was appointed first Director of the Botanical Survey of India, involving a labour so great that he resigned his professorial chair in order that he might have time to discharge the onerous duties of that appointment. After thirty-three years of strenuous work he retired from the service of the Indian Government in 1898. Living at San Remo in the winter months, he devoted in these later years his services to valuable work in the gardens at Kew, on the various lines that had occupied him in his earlier years.

His services to the Indian Empire, which were in no way restricted to his official duties, were recognised by his having conferred upon him the honour of being created in 1898 a K.C.I.E., an honour that was richly deserved. Whilst in Calcutta he was a fellow of the University there, and he took a leading part in its management. He was connected with the inception of the now famous Zoological Gardens at Calcutta, he was a trustee of the Indian Museum, and a member of the Board of the Engineering College of Bengal. Other honours were conferred upon him—the Victoria Medal of the Royal Horticultural Society; honorary membership of the Pharmaceutical Society; the rank of Officier d'Instruction publique, with a ring of honour, from the Czar of Russia; medals of the Linnean Society, and medallion portraits placed both in the Zoological and Botanic Gardens at Calcutta. You will realise from what I have been able in a few words to outline to you of his life and his work that he was one of the foremost botanists of his day, whose loss we may well deplore, while we may feel that in accepting from us in 1895 the distinction of honorary fellowship of this Society, he conferred on us an honour of which we may well be proud.

I now pass to our loss in the deaths of three of the foreign corresponding members of the Society.

Professor JOÃO BARBOSA RODRIQUES, a well-known

Brazilian botanist, was the Director of the Botanic Gardens at Rio de Janeiro. He was elected a corresponding member of this Society in 1881. Born in 1842, he originally intended to qualify himself for a medical career, but changing circumstances led him to abandon that intention. Turning his attention to botanical science through Professor Allemão of Rio, he undertook a long series of botanical expeditions in the Amazon basin—in the Southern States and in Uruguay and Paraguay. He founded a museum at Manaos, an important city on the Amazon river, and this had his care until 1899, when he became the Director of the Botanic Gardens at Rio de Janeiro—a post which he held until his death. He does not appear to have been much of a collector, notwithstanding the unrivalled opportunities offered by his extensive journeys in botanical quest. He studied from life the plants he found, and filled his portfolios with careful drawings and analyses. The task to which he mainly devoted himself was the elaboration of monographs of the palms and the orchids of Brazil—a wide field of study. Up to 1891, he published diagnoses of no less than 573 new species, 25 new genera, and 1 new tribe of orchids. Orchids, of the two, formed his favourite study. He was unable, however, to carry this to a conclusion, and his work was handed over by him to a more fortunate rival, Professor Cogniaux, who completed the work for the “Flora Braziliensis” of Martius. In the Kew collection there are several hundred copies of Professor Rodriques’ plates. He was more fortunate with the monograph of the palms, working under a commission from the Government of Brazil, taking up the work as a field botanist, studying, analysing, and drawing his specimens on the spot. The publication of his “Sertum Palmarum Brasilianarum” was carried out by the aid of a vote of the Brazilian Congress. Other scientific interests attracted him, and his published works include subjects pertaining to archaeology, paleontology, ethnography, and the Indian languages.

Of the other deceased corresponding members I cannot give you much detail. Professor EMIL CHRISTEN HANSEN, who was elected by the Society in 1887, was the head of the Physiological Department of the Carlsberg Laboratory

at Copenhagen for the study of chemistry and plant physiology with particular reference to fermentation—subjects of the greatest importance in connection with manufactures and commerce.

Dr. FREDERICK WILHELM CHRISTEN ARESCHONG, who became a corresponding member in 1878, held the important position of Professor of Botany in the University of Lund, and held an eminent position in the botanical world.

The deceased Resident Fellows are:—

Mr. JAMES BUCHANAN of Oswald House, Oswald Road, Edinburgh, became a Fellow of the Society in 1878. He was closely associated with chemical science, and he was an enthusiastic amateur gardener.

The late Mr. JAMES R. REID, C.I.E., of Magdala Crescent, Edinburgh, died there in December last year. He was born in 1838, the son of Dr. Alexander Reid of Edinburgh. He was an Indian civil servant, having been for thirty-four years in the Bengal Civil Service. He was Secretary to the Government of the North-West Provinces in 1882 and Chief Secretary to the North-West Provinces and Oudh in 1884, a member of the Board of Revenue in 1890, and member of the Legislative Council in 1891. He was created a Companion of the Indian Empire in 1890, and has passed away at the age of seventy.

The late Mr. T. A. HOG of Newliston in Linlithgowshire and of Kellie in Fifeshire, who became a Fellow of the Society in 1867, died more than a year ago, but by some accident his death had been overlooked and not intimated. He was educated at the Edinburgh Academy and the Edinburgh University, and succeeded to the family estates in 1858. He was a Justice of the Peace for the counties of Linlithgow and Midlothian, and a Deputy-Lieutenant for Linlithgow. He was thus a well-known West Lothian laird, and took a prominent interest in the affairs of his county, where he lived the life of a country gentleman.

Among the deceased non-Resident Fellows, I should refer to the late Mr. THOMAS SOUTHWELL of Norwich, a Fellow of the Zoological Society of London, whose death occurred recently at the advanced age of seventy-nine. He was for many years the Secretary and twice the President of the Norfolk and Norwich Naturalists' Society. He became a non-Resident Fellow of this Society so long ago as July 1853, and he was an amateur naturalist of the best type, his careful and painstaking work being an example even to his professional brethren. A banker by profession, he had but limited time for those detailed studies which appear to have been more directed to zoology than to botany. He was a great ornithologist; and beyond that he devoted much time to collecting and collating all information as to the distribution and migration of whales, publishing a volume entitled "The Seals and Whales of the British Seas," besides works relating to the birds of his native country.

Another old member is the late Dr. S. H. RAMSBOTHAM of Harrogate, who was elected a non-Resident Fellow in 1858, in which year he accompanied the late Professor John Hutton Balfour in a party visiting Switzerland on a botanical excursion. Dr. Ramsbotham practised in Leeds for thirty years, and died at Harrogate early this year.

Dr. JOHN FRASER, a native of Glasgow, and a Non-Resident Fellow of the Society since the year 1865, died at Wolverhampton in April last. In reply to inquiry, his daughter writes that she has asked an old friend of his—Mr Joseph Hough of Codsall Wood—to write a short notice, and I cannot do better than read to you what he has written of his friend:—

"John Fraser was born in Glasgow on 22nd March 1820, and died 13th April 1909. He was the eldest son of David Fraser, the noted stonemason, of whom a short account is given in Hugh Miller's 'My Schools and Schoolmasters.' He took his M.A. degree in 1843 at Glasgow University, where he acquired an extensive and accurate knowledge of classics, the study of which he never laid wholly aside even in the busiest part of his professional life. After he was eighty he read the whole of the 'Iliad,' and in the last three years of his life he found pleasure in reading 'Cicero's Letters.' He also read regularly the Hebrew Bible,

especially the Psalm, always a source of joy and comfort to him. Whilst a medical student at Glasgow, where he took the degree of M.D. in 1852, he was accustomed to go with Professor Arnott on botanical expeditions. After being house surgeon at the Royal Infirmary, Glasgow, he was a general practitioner during the years 1852-1854 at Byers Green and Gainford, Durham, and from 1854 to 1906 at Wolverhampton, where he held various medical appointments.

"In 1863 he took part in founding the Dudley and South Staffordshire Field Club. At that time he was a busy doctor with only scanty leisure, but this he devoted mainly to botany and geology, and in his holidays he made excursions far and near to gather, as far as possible, a complete set of British flowering plants and mosses. His principal companions in these excursions were Mr Edwin Lees of Worcester, Mr. Joseph Thompson, Vicar of Cradley, Mr. Wm. Mathews, and Mr. James Bagnall of Birmingham.

"He made a complete set of the British mosses given in Wilson's '*Bryologia Britannica*,' adding two new species—*Amblystegium Conferroides*, which he discovered in Dovedale in 1866, and *Stereodon Bambergeri*, which he discovered on Ben Lawers in 1867.

"His collection of flowering plants is very full, especially in the genera *Rubus*, *Rosa*, *Hieracium*, and *Salix*, to which he added the new species *Salix Holosericea*, Willd.

"He also made a very fine collection of most of the typical British fossils, and was elected F.G.S. in 1892. He was a deeply religious man, always actively benevolent, and his '*Nil nisi Cruce*' was exemplified in every action of his long, well-spent life. J. H."

These statements, Ladies and Gentlemen, complete the information, so far as we have been able to gather it together, of those who have gone before.

Before passing to the further business of this meeting, I wish to congratulate the Society on having had during the last year a series of fairly successful and interesting meetings, which I think over all have been well attended, and to express the hope that we are entering on a session which will even show an improvement on that

which has just passed. But I would like again to refer, as I have done before, to the anxious desire of your Council that we should do all in our power to increase the strength and the popularity of the Society. I think that botany is a subject in which an increasing interest is being taken by what I might call the general public, and I feel sure that if the Society and these meetings of ours were more generally known, we might look not only for an increase of membership of the Society, but also for a greater number of contributions of communications and exhibits of interest to the Society, and of records interesting to botanical science. I think that those of us who have friends interested in botany should endeavour to induce them to join us. We are, unfortunately, not a wealthy Society, and we have not much to offer beyond those interesting meetings and records of our doings, but I venture to think that even these are well worth offering to our friends. A larger membership would undoubtedly give the Society a stronger financial position, and that would enable us to do more in the way of making our *Transactions* attractive, and give us a wider field from which to fill their pages.

In concluding these remarks I would desire to express to the Fellows, Associates, and Members of the Society my thanks for the kind forbearance with which they have received my efforts to fill this chair, and for the kindness and courtesy which I have met with on all hands. I have felt it a great honour and privilege to preside over your meetings, and in my present position to open the session of the year on which we are now entering. I would also express my deep sense of the honour you have done me in re-electing me to the chair for another year, and I give you my assurance that I will do everything in my power for the benefit of the Botanical Society of Edinburgh.

THE PRESENT POSITION OF BOTANICAL SURVEY IN BRITAIN. By WM. G. SMITH, B.Sc., Ph.D.

The communication of which this is a summary, outlined the present position of what has come to be known as Botanical Survey. The subject has connections with

Edinburgh, for the first of the more recent papers by the late Robert Smith dealt with the Pentlands.¹ That memoir contains a sketch of the author's objects in undertaking botanical surveys and outlines his methods; although in many ways it was a new method of attacking problems of botanical distribution, it has many links with the work of the older British botanists.

In order to define "what is botanical survey," it is necessary to appreciate the various lines of study involved in plant-geography, a branch of botany which in recent decades has made rapid progress. Plant-geography seeks to answer three questions: what plants occur in the world; where they occur; why they occur in one part and not in another. The data required to answer the first two questions results in the preparation of a "flora," and in the botanical exploration of a country this is the first step towards knowledge of the plants. It entails the observation of all the plants in the area, and the recording of their distribution. Most of the phytogeographical work in Britain, as in other countries, has been of this kind, and it has resulted in a series of floras of the country as a whole, and of counties and other subdivisions. From studies of this kind has arisen the branch of floristic plant-geography which, as recently defined by A. Engler,² has for its aims: (*a*) to prepare a floral catalogue arranged in species, genera, etc.; (*b*) to prepare statistics as to abundance and frequency; (*c*) to study the physiognomy, *i.e.* to distinguish the prevailing groups of the flora—forest, bush, heath, etc.—and to ascertain their distribution; (*d*) to divide up the area into floral regions; (*e*) to study the history of the flora. The monographs in the series "Vegetation der Erde," edited by Engler and Prude, are outstanding examples of floristic plant-geography. In Scotland, Professor Trail's "Topographical Botany"³ is an important contribution to floristic studies.

The attempt to answer the question why plants occur in one place and not in another, involves consideration of

¹ Smith, Robert, "Botanical Survey of Scotland: I. Edinburgh District," Scot. Geog. Mag., July 1900.

² Engler, A., "Humboldt-Centenar-Schrift d. Gesell. f. Erdkunde zu Berlin," 1899.

³ Trail, J. W. H., "Annals of Scottish Natural History."

plant-function and is related to plant-geography on the one hand, and plant-physiology on the other: hence has arisen the branch of Physiological Plant-geography. This attempts to explain the presence of plant species and the occurrence of growth forms from the conditions of the environment. Some authors, such as A. F. W. Schimper ("Plant Geography," 1903), take up primarily the relation between *plant-distribution* and the factors of soil and climate. Other authors, notably Warming ("Ecology of Plants," 1909), are more concerned with the relation of *plant-form* to environment, and assume as a postulate that similar conditions of environment produce a similar plant-form. Other subdivisions of the subject also appear from the works of various authors: some take up the distribution and ecology of single species, others follow out plant communities.¹

The ideal botanical survey of a district or country should take account of all these points of view of plant-geography—floristic, distributional, and ecological,—and in all directions something has been done, but much remains to be done yet. The British memoirs which have used the term botanical survey in their titles are now fairly numerous (see list at the end of this paper). When analysed broadly, they will be found to deal with plant communities rather than with single species, and the relation to environment receives a prominent place. The stages of the work can in most cases be resolved into four processes:—

(a) *Selection of an area*.—This has generally been some district fairly accessible to the author, so that with frequent opportunity of inspecting the vegetation in all its seasonal phases one may expect a fairly accurate knowledge, even of a large district. The selected areas also contain, as a rule, a large proportion of vegetation little influenced by man's activities, and, as far as possible, large tracts of farmland and city areas are avoided.

(b) *Analysis of vegetation into its units*.—The larger masses of vegetation are recorded, and here a map is indispensable, and this map in a reduced form appears in the

¹ The term "plant community" is used here as an indifferent designation for any set of plants growing together: it is equivalent to the use of "group" in systematic botany.

published memoir. The actual field observations are recorded on the Ordnance Survey maps of the scale "one inch to one mile," but in many cases the authors prefer to use the larger scale of "six inches to one mile," and this is certainly the better plan. The usual practice is to colour all the existing types of vegetation covering a sufficiently large area, giving the principal plant communities a distinguishing colour and letter, and indicating mixed communities by blending colours and symbols. In naming these plant communities, the names of distinctive plant species are used, *e.g.* oakwood, heather moor, etc.

(c) *Investigations on the influence of climatic, topographic, edaphic, and biological factors and their influence on the distribution of the various plant communities.*—In the earlier primary surveys this side of the research was generally rather superficial because large areas were dealt with, and obviously the necessary observations for such investigations can only be successfully carried out over small areas. It is noteworthy, however, that each successive memoir devotes more space to the investigations on environment, and just at present there is great activity in this direction which will make itself felt in future contributions.¹

(d) *Examination of analysis from a synthetic standpoint.*—This involves deductions from the observations of the conditions which determine plant distribution and of the origin and status of the plant communities.

The present position of this aspect of botanical survey in Britain may now be briefly reviewed. Most of the work attempted has been "primary survey" or reconnaissances over fairly large areas with the view of ascertaining the outstanding types of vegetation (see list at end). The result is a series of memoirs with maps relating to districts in England, Scotland, and Ireland. The advantages of the primary survey are generally admitted: it is the best preventive of narrow views, and an essential

¹ The following papers deal more particularly with the environmental conditions of small areas:—(a) T. W. Woodhead, "Ecology of Woodland Plants in the Neighbourhood of Huddersfield" (*Jour. Linn. Soc. Bot.*, vol. xxxvii., p. 333, 1906). (b) R. H. Yapp, "Stratification in the Vegetation of a Marsh, and its relations to Evaporation and Temperature" (*Annals of Botany*, xxiii., April 1909).

preliminary to more extensive studies, and as the memoirs are expressed in equivalent terms, a comparison of areas is possible.

The analysis of the vegetation shows that throughout Britain the plant-covering consists of plant communities which recur in places widely apart, and under ecological conditions which appear on the whole to be similar, but fuller information is still needed. Types of vegetation have also been established which, although previously known to some extent, had no particularly conspicuous place in any existing literature. This is specially the case with woodland associations, and the following types of semi-natural woods are now clearly defined:—Ash woods on limestone soils in Yorkshire and Somerset; beech woods of the Chalk of Southern England; the two types of oakwood—oak-hazel with *Quercus pedunculata* dominant on deep moist soils, and oak-birch with *Q. sessiliflora* dominant on dry shallow soils; and the birch wood so characteristic of the Highlands.¹ Amongst the moorland associations so established are *Calluna* heath, *Calluna* moor, and *Eriophorum* moor, all well-defined types.

The synthetic treatment of the observations is now beginning to be evident. The earlier papers were naturally reticent in expressing broad conclusions, because the areas surveyed were limited, but with wider information it is now becoming safe to draw up conclusions. The influence of man, whether as forester or disforester, as shepherd, farmer, or game preserver, has left its mark over great tracts of our native vegetation and to British workers (as indeed to workers in ecology everywhere) it is obvious that no scheme of botanical survey can ignore man as a biological factor of the environment. It is therefore necessary to examine how man has altered a more primitive vegetation. How far the botanical survey method has traced the influence of man is seen in the "Woodlands of England," and there it is shown that although few truly natural woods exist, yet it is possible to arrange all but

¹ "The Woodlands of England," by Moss, Rankin, and Tansley, 1910, gives details of these woodland associations; it may be obtained in pamphlet form (36 pp.; price 1s. 1d. post free) from Secretary, Committee for British Vegetation, 13 George Square, Edinburgh.

the youngest plantations under the classification of woodlands which the authors propose. It has been further shown that certain methods of woodland treatment have led to the deterioration of woodlands into scrub or moorland. Thus in the case of oak-hazel copse, a widespread type of vegetation in Southern England, it has become evident that long-continued coppicing has resulted in impoverishment of humus and other changes unfavourable to tree-growth; hence the oak has gradually disappeared, leaving behind a scrub of hazel or other shrubs or, in extreme cases, a grassy common with bracken and gorse. It is also evident that many of our Scottish heather moors are retrogressive phases of former woodland, the trees becoming replaced by ling and other moorland plants, which now retain their dominance as a result of sheep-grazing and moor-burning. From correlation of observations such as these, there has arisen a strong view that what is known as "succession" plays an important part in the present distribution of vegetation. This has recently been stated by C. E. Moss¹ in a paper which traces the historical development of nomenclature in ecological plant geography. Briefly stated, the theory is that vegetation in any habitat starts in one form (*e.g.* lichens and mosses) and progresses through a succession of phases (*e.g.* grassland and scrub) till it reaches a final phase which on many soils is some type of woodland. The study of these progressive phases of vegetation has thus become an important part of botanical surveys. In conclusion, it may be pointed out that the whole study has important bearings on forestry and agriculture.

LIST OF BOTANICAL SURVEY MEMOIRS WITH MAP-SURVEYS.

1900. Smith, Robert. "Botanical Survey of Scotland. I. Edinburgh District. II. Northern Perthshire." *Scot. Geograph. Mag.*, July and August 1900. Pocket Edition by Bartholomew, Edinburgh.
1903. Smith, Wm. G., and C. E. Moss. "Geographical Distribution of Vegetation in Yorkshire. Part I. Leeds and Halifax District." *Geographical Journal*, April 1903; also Bartholomew, Edinburgh.
- Smith, Wm. G., and W. M. Rankin. "Geographical Distribution of Vegetation in Yorkshire. Part II. Harrogate and Skipton District." *Geographical Journal*, August 1903; also Bartholomew, Edinburgh.

¹ C. E. Moss, "Fundamental Units of Vegetation," 1910 (Pamphlet 2, Committee for British Vegetation, 36 pp., price 1s. 1d. from the Secretary).

1904. Lewis, F. J. "Geographical Distribution of Vegetation in the Basins of the Rivers Eden, Tees, Wear, and Tyne." *Geographical Journal*. Part I. March; Part II. September 1904.
1905. Smith, Wm. G. and Robert. "Botanical Survey of Scotland. III. and IV. Forfar and Fife." *The Scottish Geographical Magazine*, December 1904, and January, February, and March 1905.
- Pethybridge, G. H., and R. L. Praeger. "The Vegetation of the District lying South of Dublin." *Proceedings of the Royal Irish Academy*, xxv., December 1905.
1906. Hardy, M. "Esquisse de la Géographie et de la Végétation des Highlands d'Ecosse," 1906.
- Moss, C. E. "Geographical Distribution of Vegetation in Somerset." *Royal Geographical Society* (special publication), 1906.

The following will probably be issued soon, having been delayed in publication:—The Peak of Derbyshire (C. E. Moss), Hampshire and Isle of Wight and North-West Yorkshire (W. M. Rankin), Kent (A. G. Tansley), Norfolk Broads (M. Pallis and J. Shaw), North-East Yorkshire (W. G. Smith). Surveys are in progress in the following districts:—South-East Scotland, Orkney Islands, Caithness, Lanarkshire, Galloway, Dartmoor, East Devon, the Malverns, Cheshire, East Yorkshire, and Dublin.

Since this communication was read, Professor Trail, in the presidential address to Section K, British Association, Sheffield Meeting, Sept. 1910 (see *Nature*, No. 2136, p. 452, Oct. 1910) has issued a strong appeal for a complete botanical survey of the British Islands. He outlines the present state of knowledge, and points out where gaps exist. The address takes a somewhat broader view than has been attempted here, taking account of all sides of plant distribution, and it should be read by all interested in the subject.

NOTES ON THE BRITISH SPECIES OF *UTRICULARIA*. By ARTHUR BENNETT, F.L.S.

No. 1. *Utricularia vulgaris*, Linn., "Sp. Pl.," 18, 1753.—Linnaeus here mentions a major and a minor form, but no one seems to have taken them up. *U. vulgaris*, L., var. *a typica*, Meister ex Williams, "Prod. Fl. Brit.," pt. 6, 345, 1909. *U. vulgaris*, L., var. *magniflora*, Kamienski, *l.c.* These varietal names are necessary, as Meister and Williams consider *U. major* (*neglecta*) as a variety of *vulgaris*.

This seems to be generally distributed through the British Isles, occurring in about thirty Scottish counties,

sixty English, and thirty-eight Irish counties on the plan of Mr. Praeger.¹ But there may be some counties in which the specimens may prove to be *U. major (neglecta)*.

No. 2. *U. major*, J. C. Keller in ed. Schmidel, "Ic. Plant," p. 80, t. 21, figs. *a-l*, 1762, ex Williams. *U. neglecta*, Lehmann, "Schul-prog., etc., des Hamburg," p. 38, 1828.

According to Dr. Williams,² Schmidel's "Icones" were pre-Linnaean (1747), and Keller in 1762 republished twenty-five of his plates.

U. vulgaris, L., var. *neglecta*, Meister. *U. macroptera*, G. Brückner, "Arch. Fr. Nat. Mecklenberg," vii. 234, 1853.

Dr. Williams and Prah³ make Brückner's plant belong to *major*, but Boll, "Nach. Flora v. Mecklenburg," p. 125, 1864, under *U. minor*, L., says, "*U. macroptera* Brückner hierher gehört." *U. spectabilis*, Madauss, "Arch. U. Fr. Nat. Mecklenb." (1873), p. 49.

Probably in about fourteen Scottish, twenty three English, and six Irish counties, but in some cases no flowers have been seen.

Dr. Williams remarks that Herr Meister believes "that *U. vulgaris*, var. *Rhenana*, and *U. vulgaris*, var. *neglecta*, are extreme states of one species, and linked by means of many intermediates." No doubt *vulgaris* is variable, but I should rather consider them distinct.

In an account of our *Utricularias* by Rev. E. F. Linton,⁴ he gives a plate of *U. neglecta*, but the flowers unfortunately are shown without the bright red anastomosing streaks on the palate; though faded, they are well shown on specimens gathered in Cheshire by Mr. A. Croall.

I possess specimens from between Staines and Wraysbury, Middlesex, Sept. 1882. G. Nicholson, with flower-stalks 15 inches long, and the whole plant about 30 inches long. This I take to be the *U. neglecta*, *f. gigantea*, Prah, in "Krit. Flora Schleswig-Holstein" (1890), p. 173, where it is characterised "mit 1·5 m. langem Blütenstand fand Prah."

There is some uncertainty as to the application of *macroptera*. Ascherson and Graebner, *l.c.*, have a long note

¹ "Irish Topograph. Botany" (1901), 234.

² "Prod. Fl. Brit.," part 6, 1909, pp. 344-50.

³ "Krit. Fl. Schles.-Holstein," p. 173, 1890.

⁴ Proceed. Dorset Nat. Hist. and Ant. Field Club, xv. 81, 1894.

on this, and seem to consider the plant named *neglecta*, v. *microptera* of Hacker from Wesloe in Lubeck to rather belong to *U. Bremii*, Heer., and formerly Brückner¹ seems to have referred it to *intermedia*.

No. 3. *U. intermedia*, Dreyes and Hayne in Schrader, "J. Bot.," iii. 18, t. 5 (1800). *a (typica) Grafianna*, Koch in "Flora," 1847, p. 265. *3 Kochiana*, Asch. and Graeb., "Fl. N. Flachlandes," 1899, 651.

U. media, Schumacker, "Enum. Saell.," 19 1801—This again varies considerably, and we are far from knowing the life-histories of these very interesting aquatics (all our species are aquatics). Dr. Williams gives an interesting means of distinguishing this "when pulling it out of the water, is to notice the cross-section of one of the shoots which is not angular as in all the other European forms, but reniform." Occurs in twenty-nine Scottish counties, eleven English, and twenty-two Irish.

No. 4. *U. intermedia* × *minor*, Neuman in "Bot. Notiser," 65, 1903. *U. ochroleuca*, Hartmn. *l.c.*, 35, 1857. *U. brevicornis*, Celak, "Oest. Bot. Zeit.," 253, 1886. *U. ochroleuca*, f. *microceras*, J. Strandmark! *l.c.*, p. 66.

U. intermedia, sub-sp. *ochroleuca*, Lange, "Hand. Danske Fl.," 524, 1887.—This was formerly supposed to be confined to Sweden, but is now known to occur in Bohemia, Germany, Tyrol, S. Norway, Finland, and nine provinces of Sweden. In 1903,² I reported it for Scotland, based on specimens gathered at Broadford, Skye, by Mr. Symers M. Macvicar, July 1895. Others probably to be so referred are from: W. Sutherland, E. S. Marshall, 14 8 1887; Moidart, Argyll, July 1893; Dumfries, Loch Ur, J. Fingland, 1887; Wigtown, Capenoch Moss, J. M. Andrew. Since then I think specimens from S. Ebbes, Colonsay, Loch Fad, McNeill, may belong here.

Of course as reputed hybrids they vary considerably; the Dumfries specimens represent a slender and delicate form, the Wigtown probably *sub-intermedia*. Mr. S. Macvicar kindly sent me numerous specimens from Moidart, and both he and I were greatly puzzled where to place them. One would hardly suppose that a double hybrid was distinguish-

¹ M. Detharding's "Consp. Fl. Megalop." (1828), p. 5.

² "Ann. Scot. Nat. Hist.," pp. 123, 250.

able, but Melander in the "Botaniska Notiser," 175, 1887, reports a *U. litoralis* = *U. ochroleuca* × *intermedia*.

I have good specimens of the Swedish plant, gathered by R. Hartmann himself, "e loco classico," sent me by Dr. O. Nordstedt.

Others I would refer here are from: Isle of Harris, O. Hebrides, 7, 1889, Mrs. Duncan.

No. 5. *U. minor*, Linn., "Sp. Pl.," 1st ed. (1753), 18.—Dr. Williams, *l.c.*, records that Zabel has recently (1907) described a land-form of *U. minor*. This I found on Woking Heath, Surrey, July 17, 1880. Hundreds of plants were growing among moss, and in full flower.

A very delicate form gathered by Mr. A. Croall, on Flinders Moss, near Stirling, 9 7 1880, has the flowers fully expanded, and excellently dried. The flower-stalks are only 2 inches high, and the whole plant with very finely divided and small leaves. Recorded from thirty-two Scottish counties, forty-four English, and thirty-nine Irish.

No. 6. *U. Bremii*, Heer ex Kolliker, "V.P.G. Zurich," 142, 1839, and Hegetschweiler and Heer, "Fl. d. Schweiz," 984, 1840. *U. pulchella*, C. B. Lehm ex Koch, "Syn. Fl. Germ. et Helv.," 2, 666, 1844. *U. minor*, L., γ *Bremii*, Druce, "List Brit. Pl.," p. 55, sub. No. 1978 (1908).

This plant was first noticed in British books by Mr. Webb¹ (as *Bremii*), where he gives a very interesting account of its history. But there is no doubt the plant was first gathered by the Rev. J. B. Brichan of Banchoory, who found it flowering abundantly in the moss of Inshoch, Nairnshire, 16th August 1833.² He there speaks of having received specimens named *intermedia* from the Loch of Spynie in Morayshire, and he refers to the "Collectiana for a Flora of Moray," p. 2, 1839, by the Rev. G. Gordon:— "Observed to flower annually since 1830 in some holes whence turf seems to have been cut. If there be a specific difference between this and *U. minor*, the Spynie plant, upon closer inspection, will probably be found to belong to the latter species." Hence the doubt which species to refer it to; and it seems now there can be no doubt the plant was *U. Bremii*.

¹ "Journ. of Botany," 1876, p. 142.

² See "Phytologist," i. p. 259, 1842.

I have good specimens from the moss of Inshoch (but unfortunately they are not in flower), gathered on 13th August 1898 by Rev. E. S. Marshall. On these specimens I have noted: "Compared these with Schles.-Holstein specimens and they seem to me to be the same, *i.e.* *Bremii*. The shape, arrangement of the bladders, and general facies are the same 21/11/98."

I also refer to *Bremii*: "*Utricularia* sp., Loch Anna - Luinahe, Broadford, Skye. S. M. Macvicar, 7. 1895. *Utricularia* sp., East Loch, Fad, Isle of Colonsay, 26/7/1908. M. McNeill."

I have seen a specimen in Winch's "Herbarium" from the Loch of Spynie, which is placed on a sheet of *intermedia*, and I have no doubt that also is *Bremii*.

Mr. Townsend, in his "Flora of Hampshire," 2nd. ed., p. 329, 1904, says: "*U. Bremii*, Heer, possibly occurs in ditches between Herringford and Newchurch, Isle of Wight, and also on Titchfield Common; and Mr. Webb notes this flowerless bladderwort from Dr. Broomfield from the only station in that isle." To these Dr. Williams adds: "Gordon moss in Berwickshire." Another specimen I should place to *Bremii* is, "Moidart 1891, Argyll." S. M. Macvicar sp. This is very like the moss of Inshoch specimens, giving off branches in which there are very few leaves, but as many as thirty bladders.

For notes on Scottish *Utricularias*, see Linton in "Trans. and Proc. Edin. Bot. Soc." (1894), p. 110.

Dr. Williams' (*l.c.*) account of the British species is very full, but there are still points to be determined, and cultivation of the various forms is much to be desired.

There are still other specimens that it is difficult to place: especially so are those gathered by Rev. E. S. Marshall at "Lochan Feior, near Skaig Bridge, Loch Assynt, W. Sutherland, Sept. 14, 1887." Rev. E. F. Linton, *l.c.*, names this "as a suspected locality for *Bremii*." Though the foliage might pass for such, the bladders are double the size of any Continental *Bremii* I possess: still, the leaves agree well with a Slesvig specimen from Herr Fridericksen, and in a Swedish specimen (Herr Mortelin) the bladders are larger than any others seen. There are no signs of flowers, but all the branches end in "winter-buds."

REPORT OF SCOTTISH ALPINE BOTANICAL CLUB EXCURSION TO TEESDALE AND TO KIRKBY LONSDALE, 1909.

The Club met at High Force Hotel, Teesdale, on Monday, 26th July, three of the members making the journey by motor: the remainder, travelling by rail, reached Middleton-in-Teesdale Station before 2 o'clock p.m. The motor party found on the roadside, about ten miles north of High Force, *Carex curta*, *C. pulicaris*, *Saxifraga hypnoides*, *S. stellaris*, and *Sedum cillosum*; and at High Force, in the neighbourhood of the hotel, *Carex pallescens*, *C. paludosa*, *C. panicea*, *C. pulicaris*, *C. sylvatica*, *C. vulgaris*, and *Potentilla fruticosa*. A visit was made that afternoon to Widdy Fell, two to three miles north-west from the hotel, where the members were fortunate in finding all the plants noted by the Club on this hill on its previous visit several years ago.

The members were much struck by the quantity and wide distribution of *Kobresia caricina*: *Primula farinosa* also seemed to be plentiful everywhere. Caldron Snout Waterfall, as well as the fall at High Force, was a very fine sight, owing to the heavy rainfall of the previous day. The morning of this day was showery, but fortunately the afternoon turned out very fine, and the day, a comparatively easy one after the experiences of the members on Scottish mountains, was much enjoyed. It may be mentioned here for future guidance that the best route to reach Widdy Fell is by the first gate leaving the main road on the left after passing the Chapel, about two miles north of High Force: the path leads, after crossing the bridge over Langdon Beck, a tributary of the Tees, past Widdy Bank Farm, along the north bank of the Tees, right to the Caldron Snout. The following plants were found:—

Allosorus crispus, *Acereria verna*, *Asplenium viride*, *A. trichomanes*, *A. putanuraria*, *Bartsia alpina*, *Betonica officinalis*, *Blysmus compressus*, *Carduus heterophyllus*, *Carex ampullacea*, *C. capillaris*, *C. dioica* (female), *C. fulva*, *C. pallescens*, *C. panicea*, *C. pulicaris*, *Comarum palustre*, *Equisetum variegatum*, *Galium boreale*, *Gentiana verna*, *Gymnadenia conopsea*, *Habe-*

naria albida, *Juncus triglumis*, *Kobresia caricina*, *Lastrea propinqua*, *Lathyrus macrorrhizus*, *Listera ovata*, *Lycopodium Selago*, *Orchis latifolia*, *Pimpinella Saxifraga*, *Polygonum viviparum*, *Polystichum aculeatum*, *Polypodium Phegopteris*, *Potentilla fruticosa*, *Primula farinosa*, *Saxifraga aizoides*, *S. hypnoides*, *Scabiosa Columbaria*, *Sedum Rhodiola*, *Selaginella selaginoides*, *Stachys Betonica*, *Tofieldia palustris*, *Triglochin palustre*, *Viola amœna*.

On Tuesday, the 27th July, it was decided to visit Cronkley Fell, and as the members understood that the best access was by the bridge across the Tees at Cronkley Farm, they drove to the first path on the left of the road after passing the Post Office, but having crossed the bridge, they were informed that there was no public path to the mountain in that direction. They were, however, kindly led to the proper path by two sons of the farmer. This path, which is a right-of-way, leads from Wynch Bridge, which crosses the Tees, a quarter of a mile below High Force Hotel, direct over the white scars on the north of Cronkley Farm to Caldron Snout Waterfall. The day was fortunately fine though dull, and on arriving at the white scars, which is the name given to an outcrop of sugar-loaf limestone, plants of *Helianthemum canum* were found growing alongside plants of *H. vulgare*, also plants of *Gentiana verna*. A little further on, the dwarf form of *Dryas*, known to grow in this locality, was found in large quantity, as well as numerous plants of *H. canum*. One member, who had not had time to visit Caldron Snout the previous afternoon, continued by the path and, crossing the Tees by the bridge at the waterfall, spent some time on Widdy Fell looking for *Carex limosa*, without, however, finding it. Another of the party returned to the bridge along the foot of the rocks at the north side of the fell, where he found a fine plant of *Lastrea filix mas*, var. *cronkleyensis*, and saw numerous plants of *Lastrea montana* and *Polystichum aculeatum*.

The other members returned to the bridge by the way they came, and all arrived safely back at the hotel after a very enjoyable day.

The following plants were found:—*Antennaria dioica*,

Arenaria cerna, *Allosorus crispus* (on sugar loaf at top of Whiteforce), *Arctostaphylos Uva ursi*, *Carex ampullacea*, *C. capillaris*, *C. curta*, *C. dioica* (female), *C. ovalis*, *C. panicea*, *C. pilulifera*, *C. pulicaris*, *C. vulgaris*, *Draba incana*, *Drosera rotundifolia*, *Dryas octopetala*, var. *minor*, *Gentiana campestris*, *G. cerna*, *Helianthemum canum*, *H. vulgare*, *Kobresia caricina*, *Lastrea Filix mas*, var. *cronckleyensis*, *L. montana*, *L. propinqua*, var. *depauperata*, *Lycopodium Selago*, *Potentilla fruticosa*, *Polystichum aculeatum*, *Primula farinosa*, *Sanguisorba officinalis*, *Selaginella selaginoides*, *Thalictrum alpinum*, *Vaccinium Oxycoccus*, var. *Vitis idea*.

In addition to the above, the member who crossed on to Widdy Fell and returned by the north bank of the Tees found *Carex pallescens*, *C. glauca*, *C. vulgaris*, *Saxifraga stellaris*, *Scabiosa Columbaria*, and *Trollius europeus*.

As it had been arranged to leave High Force for Kirkby Lonsdale by the train about 2 o'clock on the afternoon of Wednesday, 28th July, it was decided to spend the forenoon on the banks of the Tees, near the hotel. The party crossed the Tees by Wynch Bridge: those botanising downstream found a plant well known in this locality, *i.e.* *Serratula tinctoria*; others, working up-stream, examined the numerous ferns growing on the shady banks on the south side of the river opposite the hotel, where they found two very good varieties of *Athyrium* f.f., also a polydaetylous form of *Lastrea propinqua*. Besides the above, the following plants were found:—*Carex acalis*, *C. paludosa*, *Juniperus communis*, *Lastrea montana*, *L. propinqua*, *Lysimachia nemorum*, *Populus tremula*, *Potentilla fruticosa*, *Prunus Padus*, *Stachys Betonica*, *Tarax baccata*.

At 1.30 the members left for Kirkby Lonsdale, three of them in a motor, in which they arrived at their destination before 5 o'clock, the route taken being *via* Middleton-in-Teesdale, Brough, Kirkby Stephen, and Sedbergh, a distance of about sixty miles. The road was very hilly and somewhat rough in places, but the day was very fine and warm, and the drive a very pleasant one. The remainder of the party, travelling by train, had a most tedious journey, and did not reach the hotel at Kirkby Lonsdale till about 8 o'clock,

owing to long waits, first at Barnard Castle, and secondly at Tebay Junction. After tea, the three members who motored spent some time examining the west bank of the river Lune in the neighbourhood of the town, where they found the following plants:—*Asperula odorata*, *Calamintha Clinopodium*, *Mimulus luteus*, *Origanum vulgare*, *Sedum acre*.

While waiting at Tebay Station, the members coming by rail found *Arabis hirsuta*, *Cystopteris fragilis*, var. *alpina*, *Juncus glaucus*, *Mimulus luteus*, *Ranunculus hederaceus* (sub form), *Scirpus cæspitosus*.

On Thursday, 29th July, the members motored to a point on the road to the north-west of Farleton Knott, in order to botanise on this hill, which is a well-known landmark in the south-east of Westmoreland. The members began the ascent from this point, and gradually worked their way along the various limestone ridges on its summit and on Hutton Roof Crag towards Kirkby Lonsdale. The day, though very windy, kept fair until about 4 o'clock, when heavy rain came on, making botanising most disagreeable and difficult, and rendering walking on the limestone most dangerous owing to the wet making the surface very slippery. All the well-known lime-loving plants known to grow on this hill were found, the ferns *Lastrea rigida* and *Scolopendrium vulgare* being found in great quantity and luxuriance. Large clumps of the limestone polypody (*Polypodium calcareum*) were seen, also *Arabis hirsuta*, *Arenaria cerna*, *Arum maculatum*, *Asperula cynanchica*, *Calamintha Clinopodium*, *Carlina vulgaris*, *Circæa alpina*, *Conwallaria majalis*, *Epipactis rubiginosa*, *Geranium lucidum*, *G. Robertianum*, *Hedera Helix*, *Lactuca muralis*, *Linaria Cymbalaria*, *Listera orata*, *Lastrea rigida*, *Melica nutans*, *Plantago media*, *Polygonatum officinale*, *Polypodium calcareum*, *Polystichum aculeatum*, *Sanicula europæa*, *Saxifraga tridactylites*, *Scilla nutans*, *Scolopendrium vulgare*, *Taraxacum baccata*, *Thalictrum flavum*, *Verbascum Thapsus*, *Viburnum Opulus*.

On Friday, 30th July, the party having been reduced to three, owing to members having to leave for one cause or another, motored to Ingleborough in order to visit

the Craven Nursery there, belonging to Mr. Reginald Farrer, which the members were shown round by Mr. Redman, the foreman, with whom the President had had considerable correspondence.

The members much enjoyed their visit both to the nursery, where they saw many very rare alpine, and to the private gardens and to the recently made natural rock garden bordering the lake. They were also shown *Arenaria gothica* growing in its native habitat. In the evening of this day the following plants were found in the neighbourhood of Kirkby Lonsdale:—*Campanula latifolia*, *Cherophyllum tenuifolium*, *Holosciadium nodiflorum*, *Malva moschata*, *Tamus communis*, *Torilis Anthriscus*.

On Saturday, 31st July, the President and Secretary left Kirkby Lonsdale by motor in order to visit the famous garden at Levens Hall, where several hundred specimens of topiary work were seen, this being the most famous garden of the kind in the country. Thereafter the journey was continued *via* Kendal, where fine collections of varietal forms of native ferns owned by Messrs. George Whitwell and J. J. Smithies were visited, on to Lowood Hotel on Lake Windermere, where the week-end was spent. The weather during the week was somewhat broken, but on the whole a very pleasant time was passed, many of the plants gathered and the localities visited being new to the majority of the members of the party.

The wonderful limestone formations on Farleton Knott, cleft and cut in every direction and worn into every conceivable shape, will well repay a visit by anyone who happens to be in that neighbourhood; while the outcrop of sugar-loaf limestone at High Force is also most interesting, both being very different from anything we are accustomed to in Scotland.

NOTES ON PLANTS OBSERVED DURING A VISIT TO CHILE.

By W. BALFOUR GOURLAY, B.A., L.R.C.P. & S.E.
(Plates VII. and VIII.)

To write an adequate account of the flora of Chile could only be undertaken by a trained botanist, after years of travel and research in a country where conditions vary

so greatly in its different parts. As I spent only a few months in Chile in the year 1908, all that I can hope to give you is a slight impression of the general conditions of the country as a whole, and a slight sketch of the flora of the few places visited by one who has little botanical knowledge, and takes but an amateur interest in the great subject of botany.

Chile is a country with a wonderfully varied flora, as will be readily understood when the following conditions are borne in mind. The country stretches from north to south, a distance of 2700 miles, from the arid deserts about Tacna (lat. 18° S.) to Cape Horn, with its snow and ice, about lat. 56° S. The country, whose width varies from 100 to 250 miles, may be regarded as the western slope of the Andes: so that, on the whole, one ascends on proceeding inland. In addition to this, the rainfall decreases continuously from south to north in association with a gradual change in the direction of the prevailing winds, opposite in character to the direction of the hands of a clock. Thus in the south the prevailing wind is westerly and the annual rainfall is very great. Further north the prevailing wind is found to be south-westerly, with a diminished rainfall: while in the extreme north the wind blows always from the land, and rain hardly ever falls.

	Latitude.	Mean Temperature.	Annual Rainfall.
Tierra del Fuego	52-55° S.	42° F.	{ Great in S. & W.
Ancud (Island of Chiloe) .	42°	53° F.	130 ins.
Valparaiso	33°	59° F.	10-20 ins.
Iquique	20°	64° F.	{ practically nil.

In the desert of Atacama, in the north, the temperature may fall from 100° F. in the day to 36° F. at night. At certain times of the year in Valparaiso a sudden drop of 30° of temperature is often experienced at sunset. One cannot move in any direction in Chile and remain in the same conditions with regard to temperature, altitude, or rainfall. Consequently, a small change in one's position

corresponds with a considerable change in the surrounding flora.

Chile may be divided into three regions whose boundaries merge into one another.

In the arid northern region vegetation is very scarce.

The central region from Santiago to Temuco is very fertile, and is mainly occupied in commerce and agriculture. In the northern half of this territory, which has a short rainy season followed by a long dry one, irrigation is required, the water being supplied by numerous shallow streams which flow down from the Andes. The canals and waterways, lined, as they are, by tall poplars at regular intervals, form a characteristic feature of this part of Chile.

From Temuco to near the Straits of Magellan there is an abundant rainfall, and dense forests prevail.

Our ship, the s.s. "Oronsa," left Liverpool in July 1908, and touched at La Rochelle, Oporto, Lisbon, the Cape Verde Islands, Rio Janeiro, Monte Video, and Port Stanley in the Falkland Islands. These islands resemble our own Outer Hebrides in appearance, and are largely tenanted by Scottish sheep-farmers. The climate is very severe. Leaving Port Stanley, we passed through the Straits of Magellan, thereby obtaining an idea of what the southern end of South America is like in cross section. The country bounding the eastern end of the Straits is flat, dry, and uninteresting. A little gold is found here in the stream beds. Passing through a narrow part of the Straits, we were able, with the help of glasses, to discern on the island side a herd of wild guanacos browsing on the scrubby little bushes which were all that could be seen in the way of flora. As we proceeded the scenery became more mountainous, and vegetation increased.

We spent the night and some hours next day at Punta Arenas (Sandy Point), the most southerly town in the world. I was anxious to walk to the forest and examine the trees. Unfortunately a wide belt of trees behind the town had been burned, leaving only blackened stumps. The edge of the forest did not look far off, but the distance was deceptive and the track difficult, and I had to return with my object unaccomplished, or risk the chance of being left behind. The soil was peaty, and the flora similar in

general appearance to that of a Highland moor. There were grasses and mosses, and a little plant with a black berry and with a habit of growth and appearance resembling *Empetrum* or *Vaccinium*. On the dry ground was a *Berberis* with small elliptical leaves. Judging by the stumps, the trees were not conifers. I think they were a species of *Nothofagus* or Southern Beech, probably *N. antarctica*.

Proceeding further, we were held up by snow showers, and had to remain at anchor in a little sheltered bay for more than twenty-four hours. A neighbouring hillside was covered with dense forest which invited inspection, but I was unable to obtain leave to go ashore. An officer, who had been ashore there before, told me that the trees were not conifers except for an occasional cypress (possibly *Libocedrus tetragona*).

Next morning we were steaming in a north-westerly direction up the narrow and most beautiful part of the Straits. On the northern side were high snow mountains with glaciers, the lower slopes being clothed with a dark green belt of forest. A species of *Nothofagus* grew down to the water's edge, and showed a very remarkable degree of wind-pruning. The trees near the water's edge were only a few inches in height, but inland they showed a rapid increase in stature. The trees were crowded together like Box, and looked as if one could walk on the tops of them. I think the condition must have been partly due to the salt from the water. (The water is probably only moderately saline in these places.)

Leaving the Straits, our next port was Coronel, which is a coaling station. Here we were met by a friend who lives in Concepcion, and two of our party (including myself) accompanied him to that town by means of a light railway which is owned by the Arauco Colliery Company. We jogged along over a flat sandy plain covered with aromatic evergreen bushes, mostly "boldo" (*Peumus boldus*), a little white anemone covering the ground in patches.

There were plantations of *Pinus insignis* on the hills above Concepcion. The open ground on the hills was covered with charming little flowers, the only one I can remember being a small strawberry plant with a very large

blossom (*Fragaria chilensis?*). In a natural wood I saw that beautiful creeper, the "copihue" (*Lapageria rosea*), "quintral" (*Loranthus tetrandus*)—a parasite with long, tubular, scarlet flowers, and a small and very beautiful species of *Cassia*. A small bamboo formed a matted tangle of undergrowth, which made walking almost impossible except on the path.

We joined the "Oronsa" again next day at Talcahuano, and sailed for Valparaiso.

The country about Valparaiso is very hilly. The soil, which is dark red in colour, is very brittle, and is furrowed and fissured by the streamlets which descend during the short rainy season, when rain falls very heavily. Owing to the dryness of the atmosphere, many of the small herbs come up, produce flowers and seed, and die down again with great rapidity, so that the aspect of the hillside changes markedly from week to week. One day the hill is all white in places with a small liliaceous flower (*Ornithogalum* sp.). Ten days later, hardly a specimen can be found, but the hillside is pink with *Leucocoryne*, for example. And so the changes are rung, and the collector is hard put to it to keep pace with the fugitive flora.

Striking amongst the smaller plants are *Passiflora carulea*, *Oenothera acutis* and *O. Berteriana*, *Triptelion spinosum*, *Sisyrinchium speciosum*, *Calandrinia grandiflora*, and some orchises of the genus *Chlorita*, with certain species of *Louisa* and *Alstramaria*. *Calceolaria* and *Orealis* are represented by a number of species, the latter being always either pink or yellow. A maritime *Orealis*, with yellow flowers, has thick fleshy stems and leaves.

Familiar flowers are *Tropaeolum tricolorum*, and species of *Schizanthus*, *Salpiglossis*, *Escallonia*, and *Alonsoa*. The Compositæ are well represented, *Matisia* being an interesting genus. Among the larger flowering plants are tree *Senecios*, a tall erect *Cactus*, and a large red-flowered *Lobelia* which has a great attraction for the humming-birds. The order Bromeliaceæ is represented by the curious "chagual," of which there are two species, one with yellow and one with greenish-blue flowers (*Puya chilensis*, and *P. Whytei*, Hook. = *Pitcairnia carulea* respectively). A bushy *Euphorbia* is everywhere present.

The native trees about Valparaiso are for the most part small and of slow growth, while the majority of them are evergreen. The "coligue," a species of bamboo, forms an undergrowth in many places. Native woods contain the fragrant "boldo" (*Peumus boldus*), "peumo" (*Cryptocarya Peumus*), "quillai" or soap-bark tree (*Quillaja saponaria*), "maqui" (*Aristotelia maqui*), the fruit of which resembles small cherries, and the handsome but poisonous "litré" (*Rhus caustica*, Hook. et Arn. = *Lithraa venenosa*, Miers.). To touch this tree, or merely rest within its shade, produces in some people a severe form of dermatitis, the symptoms being a rash, accompanied by great irritation and swelling. The beautiful evergreen "patagua" (*Tricuspidaria dependens*) grows a few miles inland in damp places. The "honey palm" (*Jubaea spectabilis*, H. B. et K.) grows in several of the valleys near Valparaiso, especially fine examples being seen in the neighbouring Salto Valley. The tree is greatly prized for its sweet sap, from which is prepared by evaporation the *miel de palma* or "palm honey" which, with omelette, forms a favourite Chilean delicacy. Formerly the natives, with typical improvidence, were wont to cut down the trees to obtain the sap; and the palms, from being exceedingly abundant, became comparatively scarce. Darwin in the year 1834 endeavoured to count the trees on one estate near Petorca, but failed, after having numbered several hundred thousand. In 1859 Dr. Philippi wrote: "There are now few palm-groves remaining, as at Cocalen, at Ocoa in the valley of the Aconcagua river, and the Cuesta de las Palmas between Petorca and Illapel." At Ocoa, some forty miles E.N.E. of Valparaiso, the palm-trees are now tapped, and the honey, evaporated and tinned, is sold throughout the Republic. With such trees and shrubs are the valleys clothed, while the higher plains are barer, being dotted over with an orange-flowered and sharp-thorned *Mimosa*. Other scrub includes "chacai" (*Discaria* sp.) and "arrayan" (*Eugenia apiculata*), with an occasional clump of evergreen trees such as the graceful "maiten" (*Maytenus boaria*). The "belloto" (*Bellota Miersii*, C. Gay), a very handsome evergreen tree with thick glossy leaves, grows particularly well in the Central Valley, where it affords excellent shelter for

cattle. The nuts which fall from it are devoured by pigs with great enthusiasm. Where the ground is damp, one may find a species of *Ribes*, a handsome climber, the "coile" (*Lardizabala bitermata*), or the pink *Matisia* (*M. ilicifolia*).

The commoner forms of timber used for building purposes in Valparaiso are the native "roble" and "rauli" (*Nothofagus obliqua* and *N. procera* respectively), from the south of Chile. "Alamo" or French poplar, grown in the country, is used where a soft wood is required, as in ceiling mouldings. The best wood used for building purposes is that of the Douglas fir (*Pseudotsuga Douglasii*), known commercially as "Oregon pine," which is imported in large quantities from North America.

Though native trees about Valparaiso grow very slowly, most of the trees introduced from abroad grow with extreme rapidity. Among them we see *Aruncaria creedsa* from the Norfolk Islands, *Caprossus macrocarpa* from California, *Eucalyptus*, *Casuarina* and *Grevillea* from Australia, and *Pinus canariensis* from the Canary Islands. The French poplar is of very great value to the Chilean farmer. The trees are planted, about two feet apart, at the edge of each irrigation canal, and are of such rapid growth as to be ready for cutting when about fourteen or fifteen years old. They are then sold standing, or cut into boards by the farmer himself with a portable saw bench. Besides yielding timber, the lines of poplars protect the cattle in summer from the sun, and in winter from storms of rain and wind. In some districts the poplars are attacked by that beautiful but destructive parasite, the "quintral" (*Loranthus tetradas*), which is spread from tree to tree by birds. As in the case of its British relative, the mistletoe, the "quintral" berry has very viscid juice, which prevents the bird eating the fruit from swallowing the seeds. These it scrapes from its beak on to a branch, where they adhere and germinate. When firmly rooted, the parasite destroys whole avenues of poplars. The weeping willow, also planted beside streams and canals (where it grows with singular luxuriance), is similarly attacked. In the neighbourhood of Valparaiso, it was only after careful search that I found the parasite growing on a native host (*Discaria* sp.), although rampant on the alien poplars and willows.

Among alien flowers growing wild about Valparaiso are:—*Eschscholtzia californica*, *Argemone mexicana*, and *Centaurea melitensis*. The *Eschscholtzia* escaped from the garden of an English lady living in Viña, a suburb of Valparaiso, about forty years ago. Aided by an excellent seed-dispersal mechanism, it spreads along the cliffs and railway embankments, and wherever the ground is broken. However, one occasionally meets with an isolated patch of it miles from any other specimens. Growing in great orange masses on the cliffs between Viña and Valparaiso, it forms a spectacle of the most dazzling brilliance.

A great many of the plants about Valparaiso and in the comparatively dry parts of Chile are aromatic. Some people say that they can smell Chile when miles out to sea. A large proportion of the plants in such a neighbourhood are prickly. Especially is this the case with the very small plants. The ground feels prickly to the hand.

Shortly after arriving in Valparaiso, I travelled south and visited Temuco and Valdivia. Unfortunately I had no apparatus with me for collecting and drying plants, owing to some of my property having been stolen from the steamer on the way to Valparaiso.

In passing through the Great Central Valley, Chile's greatest agricultural asset, I was much struck by the alien flora. The growth of bramble was such as no one who had not seen would believe. It grew fifteen feet up the poplars lining the fields, and at the same time formed hedges about six yards broad. In some places it grew entirely by itself, the interlacing stems forming dome-shaped masses about six feet high. An immense total of valuable farm-land is thus wasted by being covered by this persistent and useless bush. When once the bramble has taken root, its eradication from the soil is a matter of great difficulty. Various expedients have been tried. One method is to burn the bushes, and then fence in the site, turning goats into the enclosure. The animals eat off the new shoots as soon as they appear; and, in the course of time, the roots die. Some parts of the land were overrun by that handsome artichoke, the cardoon (*Cynara cardunculus*), which, however, attains its maximum development on the plains of the Argentine.

After passing over a high table-land, we reached the forest country of the south. At first we passed through miles of blackened stumps of burned trees, with little settlements here and there near the new railway over which we were travelling. Corn was seen coming up between the prostrate stumps of trees which had not as yet been removed. Later we passed through dense forests of evergreen trees with an occasional bush of *Berberis Darwinii* covered with orange blossom.

Valdivia, with a climate like that of the west of Scotland, is very attractive. (Since my visit, the town has been destroyed by fire.) The trees there are mostly evergreen, and many of them have conspicuous flowers. One of the most beautiful is the "canelo" or Winter's Bark (*Drimys Winteri*), with bright green leaves and clusters of white flowers. Flowering branches of this tree are used with charming effect in ecclesiastical processions. Of the southern beeches, the "coigue" (*Nothofagus Dombeyi*) is the most handsome. The shallow streams were overhung with the golden blossom of the "pelu" (*Sapanea tetraptera*), a small leguminous tree.

I was surprised to find two species of climbing violets. The flowers of one species were mauve in colour, and the other of a rose pink. These plants climbed, without specialised organs, by twining up neighbouring plants. The forms of leaf and flower were not unlike those of our wild violets. The mauve species tended to straggle over the ground and twist upon itself, but the pink species climbed two or three feet up the hedges or neighbouring plants.

Primroses, foxgloves, and gorse grew near the town, and were probably introduced by the Germans, who form a large community.

We left Valparaiso early in December, crossing the Andes, and traversing the Argentine Republic. During our ascent on the mountain railway, the vegetation grew more scarce. We passed tall cacti covered, in patches, with a blood-red parasite. The tunnel being at the time incomplete, we crossed the summit in coaches, which rattled down the steep Argentine descent and swung round sharp corners in a somewhat alarming manner. Even quite near



Honey Palm (*Jubaea spectabilis*) and French Poplar attacked by *Loranthus tetrandus*.

the summit, at a height of nearly 13,000 feet, I noticed occasionally a small composite flower.

I stayed for a few days at Puente del Inca, on the Argentine side of the Andes, to examine the plants in this neighbourhood, at a height of 9000 feet. Among the species most conspicuous were *Tropaeolum polyphyllum*, a *Berberis*, and species of *Adesmia*. I also found a small *Calceolaria* and many of the Compositæ.

At Mendoza, we left the Transandine railway, and, crossing the great plains of the Argentine, sailed for Liverpool from Buenos Aires, thus completing a most interesting visit to the New World.

THE GENUS *CAREX* IN BRITAIN. BY ARTHUR BENNETT.
F.L.S.

In the "Annals of Scottish Natural History," January 1910, pp. 46-52, is a paper entitled "Critical Remarks upon the *Cyperaceæ-Caricoidææ* as treated in 'Das Pflanzenreich' by G. Kükenthal, 1909, Leipzig," by Mr. G. C. Druce.

In the following notes I have to some extent followed the above "remarks," amplifying them in some cases. I have done so because my name happens to be mentioned here and there.

I have not seen this part of the "Pflanzenreich," so cannot say to what extent the author recognises his indebtedness to my late friend Mr. C. B. Clarke of Kew; but having often talked matters over with Mr. Clarke, and seeing many MSS. of the author, I know how much he owed to Mr. Clarke.

I have given the original descriptions of some varieties named that do not appear in British floras.

Carex binervis, Sm., var. *alpina*, Drejer (1), No. 52.

C. Sadleri, Linton.

C. binervis, var. *nigrescens*, Druce.

C. frigida, Syme, non All.

"β alpina humilior specie paullo brevioribus facrō ad Quivig! Lyngbye. Hujus plantæ modo 2 frustula male conservata in herbaria nostra deposuit Lyngbye, quæ tamen satis luculenter probant, plantam hujus floræ civem esse."

In No. 15 I refer var. *nigrescens* to *β alpina*, Drejer.

Carex flara, L. var. *rostrata*, Bailey. "Bot. Gazette" (1888), 84.

"Plant less yellow, or entirely green; spikes more scattered, the lowest two or three inches remote and usually conspicuously stalked; beak shorter, straight, or nearly so."

Vancouver Island, Macoun, *C. irridula*, Boott. "Ill." *Carex*, t. 523, may possibly belong here, *l.c.*

Carex Goodenovii, Gay, var. *strictiformis* (7), Bailey (*sub vulgaris*).

"Tall and lax (1½ to 2½ feet high), the leaves long and narrow; staminate spike, longer peduncled; pistillate spikes looser and often longer than in the species, the perigynia never being so densely packed and usually becoming browner. This plant stands midway between *C. vulgaris* and *C. stricta*." This American *stricta* is much like the var. *virescens* of *C. aquatilis*, Wahlb.

Carex rostrata, Stokes, var. *utriculata*, Bailey (No. 3).

C. utriculata, Boott in Hook., "Fl. Bor. Am.," ii. (1840), 221.

To this Herr Kükenthal refers the Irish plant I named in error *C. rhynchophylla*.

Professor Bailey (No. 7) writes: "A study of much material, in field and herbarium, renders the differences between the European *C. rostrata* and our plant apparent. From the European species *C. utriculata* is separated by grosser habit, lack of stoloniferous character, broader and proportionately shorter leaves, heavier and more scattered spikes, of which the lower are less peduncled, and much sharper scales."

Carex acuta, L., var. *strictifolia*, Ueetz. = *C. strictifolia*, Opiz in "Reich. Ic.," viii. (1846), 15 = *C. proluxa*, Fries, "Mant.," iii. (1842) 150. Ueetz. in "Sch. Ges. Nat. Cult.," (1875), p. 30, seems to be the first to have made the above combination; but Hartmann, "Hand. Sk. Fl.," 4th ed. (1843), calls it *C. acuta*, var. *prolira*, and this must stand (Bennett, 15).

No. 14. Andersson here discusses the various forms of these two species as they occur in Swedish Lapland, and

¹ *C. stricta*, Lam., "Dict. de Bot.," iii. (1789), 387, not of Smith.

shows, as the elevation, etc., increases, they become dwarfer, and with other lessened characters. He mentions with great approval Laestadius's "*Loca Parral. plant. in Suecia boreali observatiis.*" This work, written in 1832, was not published until 1839. It is written in Latin, and contains a vast number of notes upon the variation of plants as induced by climate, etc. Much in both these papers are of value even to-day.

C. ampullacea brunneusens, And.—"The halm, seldom exceeding 2 feet in height, is quite obtuse, clothed below with conspicuous reddish scales; the leaves lighter than usual and shorter; f. spikes shorter, of a high brown colour, especially noticeable after pressure. The utricles are less inflated, with few indistinct nerves. Male spikes always two." Andersson, *l.c.*

C. vesicaria alpigena "acquires a shorter but more robust halm, clothed by broad-keeled leaves, with triangular summits as long as the halm, and surrounded below by dry sheaths. Usually two female spikes, rarely three or one, the lowest stalked all erect, 1 inch long, with brown or blackish shining scales; stigmas three."

C. vesicaria dichroa.—"The halm is about 2 feet long, somewhat curved at the base, the leaves attenuated towards the point, f. spikes more or less lax, the lowest almost always nodding, glistening from the scales, which are scarious at the edges and points; male spikes mostly two." Andersson, *l.c.*

C. rostrata, var. *sparganifolius*, Murray, Scotland (Druce) in "*Das Pflanzenreich*," 1910.

C. rostrata × *vesicaria*, Figart, 1887.

× *C. Pannwitziana*, Figart (1887). — Ascherson and Graebner, "*Syn. Fl. M. Europ.*" (1903), 213, refer *C. Friesii*, Blytt, to this, but the specimens of this I have seen seem to me different.

I have this from Perth, gathered by Dr B. White; and Rev. E. S. Marshall gathered it in Glen Callater. (Bennett No. 15.)

Herr Kükenthal uses *C. Hudsonii*, A. Benn. (for *C. stricta*, Smith, non Lamarck), instead of *C. elata*, Allioni. There is no specimen in Allioni's herbarium, and there is some doubt whether the name applies to *stricta*, Sm. or *acuta*, L.

C. aquatilis, Wahlb. (Bennett, 15).—Herr Kükenthal gives a new form, *angustata*, Kük., from Forfar (Somerville) and Easternness (Marshall); var. *spagnophila*, “Fr. Sum. Veg. Scand.,” 72, 1846.

From Clova (Boott); S. Aberdeen (Druce).—This is very near var. *epigejos*, Læst., “Vet. Ak. Handl.,” (1822), 339, but Andersson says of the latter: “squamis fusco-atris fere brevioribus, fusco iridis”; of the former, “squamis pure viridis.”

The plant from Methven Bog, named *epigejos* by Dr. Almqvist seems not to belong to that variety;—see my remarks in No. 15. There is some discrepancy between the Herb. Normale specimens and the description in Andersson and his drawing.

C. alpina, Sw. (1798) is used instead of *C. Halleri*, 1766–72; but there is a *C. alpina*, Schrank, “Baier. Fl.,” 299 (1789) = *C. sempervirens*, Will., so that perhaps it would be well to go back to *C. VahlII* (1801).

Lang in Linn., xxiv. (1851), p. 563, notes that his name *C. borealis*, Lang, “Flora,” March 1843, p. 142, antedates Fries’ *C. epigejos*, “Bot. Not.,” July 1843, but of course this only applies if the plant is held to be a species. He says it is intermediate between *C. aquatilis* and *C. rigida*, and that specimens sent to him have borne both names. The remark is made “Ann.,” *i.e.*, p. 50, as to Scotland, “does it really occur there.” As Herr Kükenthal has himself named specimens from “Corrie Kander” (see No. 16) as “*C. aquatilis*, var. *epigejos*, Anderss.” (why the var. is placed to Andersson I do not know, as Læstadius named it *aquatilis* β *epigejos* in 1822), it seems it does occur there.

The *salina* form I name (15) as having seen only three specimens of, *i.e.* one at Kew, one in the Boswell herbarium, and one sent me by Dr. Buchanan White as “the alpine form from Clova of *aquatilis*,” is a difficult one to give a name to; it certainly comes very near the *C. epigejos*, Fries (non Læst.), “Bot. Not.,” 105 (1843), see No. 15 = *C. discolor*, “Nyl. Spic. Fl. Fenn.,” iii. 12 (1846).

C. fusca, Allioni, “Fl. Ped.” (1785), ii. 269.—“A good specimen in Allioni’s herbarium.” Bailey, No. 7.

C. polygama, Schk., “Riedg.,” 84, t. 76 (1801).

C. subulata, Schum., "En. saell.," i. 270 (1801).

C. Buxbaumii, Whlbg., "Act. Holm.," 163 (1803).

The first is the proper name if the law of priority is followed.

Herr Kükenthal substitutes "*concolor*, (Br.), Kük.," for the *C. rigida*, var. *interalpina* of Læstadius (1839). If by this he means *C. concolor*, R. Br., in supp. app. "Parry's Voy.," 218, 1823, then I think he is wrong, as the plant of Brown is nearer the var. *saxatilis*, Fr., i.e. nearly the typical form "*interalpina*, Læst. (luxurians), pedalis et ultra; foliis latissimus inferioribus subexcurvatis, superioribus erectis; bracteis late foliaceis; planiusculis; spicis fem. inferioribus exserte pedunculatis, clavatis, subrarifloris, ad masculum approximatis; glumis acutiusculis." Andersson, No. 20.

The original description of Læstadius in the "Loca Parell." does not lend itself to quotation. Andersson first putting it into descriptive form.

C. lagopina, Wahl. (1803), is used instead of *C. Luckenalii*, Schkr. (1801). Richter, "Pl. Europ.," i. 151, 1890, places the latter under the former, and Kunth, "En. Pl." ii., 1837, also does so, but uses "*C. leporina*, L., Sp. 2, 1381, non Suec."

Carex aquatilis $\times$ *kattegatensis*, Fr. = $\times$ *C. Grantii*, A. Benn. in No. 15. Richter omits *C. kattegatensis*, Fries, in "Ind. sem. hist. Up.," 1857. This hybrid was gathered in Caithness by Mr. Grant of Wick.

C. aquatilis $\times$ *Hudsonii* = $\times$ *C. hibernica*.—A. Benn. in No. 15. Kerry, Ireland, W. Scully.

C. aquatilis, Wahlb.—Mr. C. E. Salmon, No. 17, rightly remarks to a var. *angustifolia*, Kuhl: "It seems unwise to name individuals in this way." The fact is, *aquatilis* in Sweden, Norway, and Finland varies greatly, any number of so-called forms may be made of it, and their collation seems almost impossible when hundreds of specimens are seen!

"And *C. salina* is worse, no two authors agreeing in the disposition of the forms; even in the Caithness *C. kattegatensis*, Fr., the series of twenty two gatherings kindly made for me by Mr. and Miss Grant, along the whole extent of its growth on the Wick river, these it is

impossible to collate with European forms; they are individual variations of a species."

C. canescens, L., is used for *C. curta*, Good.—Varieties under it are given:

1. Var. *tennis*, Lang, in "Linn.," xxiv. (1851), p. 538. Ben More, Druce.

"*γ tennis*.—Tota valde gracilis et debilis habitum fere referens Caricis Persoonii. Spiculæ paucifloræ. Hujus memorabilis formæ caespitem circiter culmorum octodecim in consortio normalis plantis prope Erlangum quondam legi.

"Habitus Caricis canescentis statim a præcedente Carice norvegica differt. Color normalis illius pallide canescens, quare optime canescens nominata est Carex. Spiculæ multifloræ et fructus conspiciuntur minores sunt quam Caricis norvegicæ," pp. 538–9, *l.c.*

3 *robustior* (Blytt).—spiculis crassis, fulvescentibus, summis valde approximatis; fructibus late ovatis." Andersson, No. 20, p. 57.

2. Var. *robusta* (Blytt) in Andes, "Cyp. Scand." (1849), 57. The reference to the "Sum. Veg. Scand." (1846), is to a name only. That to the "Herb. Norm.," fasc. 7, n. 85, Sept. 1840, is to the plant. Blytt's own description is in "Norge's Flora" (1861), p. 201. Lang, *l.c.*, has a var. *robusta*.

3. Var. *fallax*, F., Kurtz in Asch. et Graeb., "Syn. Fl. Mitteleurop." ii. 2, 61 (1902)=var. *dubia*, Küken., non Bailey (Scottish Highlands, Druce).

The var. *robusta* is the plant long called *alpicola* by British botanists. Lang's plant has "spiculæ ut planta tota crassiores, habitu non mutato."

C. fulva, Good., is named as *C. Hornschuchiana* × *Æderi*, of which three forms are given:—

C. glauca, "Scop. Fl. Carn.," 2nd ed., 223, 1772. (In the first edition, 214, 1760, without a name.)

C. flacca, Schreber, "Sp. Fl. Lips.," add. 1771. The *C. glauca*, Murray, "Strip. Goett.," 1700.

In a letter Mr. C. B. Clarke writes as to this:—
Printed by Nyman, copied by nearly all since, even by Richter, who is usually more careful. But as far as we can discover here (*l.c.* Kew), it is purely a falsehood with a purpose; we cannot find the name *glauca* in Murray's

‘Gottingen Flora,’ 1700, on the page cited, or on any other page: nor can we even find the plant under any name. Now, *C. recurva*, Good., is very fully and well described by Goodenough in his paper read 1792, published before 1794: the name *recurva* is not taken up by Hudson till his edition of 1798.”

C. Ederi, Retz.

C. Ederi, *C. subglobosa*, Storek., “Salzb.” (1857), 76 = *C. subglobosa*, Mielich., “Flora,” xxii. (1839), 257. Herr Kükenthal records it a “forma” from Lough Neagh (Ireland), Druce.

C. Ederi, Elub., sub. sp. *adonocarpa*, Anders., “Cy. Scand.,” 25, 1849; not as a variety.

C. elytroides, Fries, from Anglesea, was disposed of by Mr. Marshall in No. 16, but with the reference I do not agree.

C. ligyrica, Gay (Scilly Isles), was named by Boeckeler, but no doubt some of his work is not good. But of course his name is not mentioned.

C. diluta, Bieb., and *C. punctata*, Gaud.—A supposed authentic specimen of the first shown me by Mr. C. B. Clarke was undoubtedly *punctata*, and I see Trautvetter (Supp. “Led. Fl. Ross.”) conjoined them, as did Treviranus in “Bull. Soc. N. Mos.” (1863), i. 541. And Mr. Clarke observed that his Kashmir specimens of *C. diluta* had a considerable range of variation, and that Cabul specimens of *diluta* were marked *punctata* by Boeckeler.

- (1) DREJER.—Revis. Crit. *Caric. borelium*, 1841.
- (2) BAILEY, L. H.—Notes on *Carex*.—Bot. Gaz., 1888, 82–89.
- (3) BAILEY, A. PREM.—Syn. of N. American Carices, pp. 59–157. Proc. Am. Acad. of Arts and Sciences, 1886.
- (4) BAILEY.—Bot. Gaz., 117–122, 1884.
- (5) “ “ 137–141, 1884.
- (6) “ “ 203–208, 1885.
- (7) “ Studies of the Types of various species of the genus *Carex*.—Mem. Torrey Bot. Club, i. (1889), 1–85.
- (8) “ Bot. Gaz., 293–295, 1885.
- (9) “ “ 317–319, “
- (10) “ “ 379–382, “
- (11) “ “ 328–330, 1886.
- (12) “ “ 82–89, 1888.
- (13) “ Jour. Bot., xxvi. (1888), 321–323.
- (14) ANDERSSON.—On *C. ampullacea*, GooL., and *C. vesicaria*, L.; with Remarks on their Modifications of Form. N. J. Andersson in Nya Botaniska Notiser, 1850.
- (15) A. BENNETT.—Jour. Bot., June, July, 1897.

- (16) E. S. MARSHALL.—*L.c.* (1895), 73-82.
- (17) C. E. SALMON.—*L.c.* (1906), 224-227.
- (18) McLAREN.—*On some British Carexes*.—*Bot. Gaz.*, iii. (1851), 17-27.
- (19) PRIESTLEY.—*On Carex*.—*Trans. Bot. Edin.*, iv. (1853), 71.
- (20) ANDERSSON, N. J.—*Cyperaceæ Scandinaviæ*, 1849.
- (21) RICHTER.—*Plantæ Europææ*, i., 1890.—*Carex*, pp. 145-171.
- (22) ASCHERSON and GRABNER.—*Syll. Fl. Mitteleurop.*—*Flora Carex*, v. 264, 1902-3. Index, 1-33, 1904.

A very full Bibliography of *Carex* will be found at pp. 154-157 (1753-1886) in Mr. Bailey's No. 3 Paper.

NOTE ON THE RELATIONSHIPS OF PRIMULA ELATIOR AND
P. VULGARIS TO SOIL CONDITIONS. By R. S. ADAMSON,
M.A., B.Sc.

The observations contained in this paper do not in any way profess to be complete. They are the result of some investigations in a few areas of more or less natural woodland in Cambridgeshire, and more especially in Gamlingay Wood, on the borders of the counties of Cambridge and Huntingdon.

In this district at the present time *P. elatior* is confined to woods of the *Ash-Oak* type on Boulder Clay. It does not occur at all in the damp meadows, where it is so frequent in its Continental localities.

The Boulder Clay in Cambridgeshire is for the most part a very heavy fine-grained clay, with few stones and very little sand or gravel intermixed. The lime percentage is somewhat variable, but on the whole it is a distinctly calcareous soil. For agricultural soils Foreman¹ gives the lime content as varying from 1 per cent. to 5·7 per cent., but in the woods it seems to be rather higher, sometimes reaching 7·08 per cent., with an average of about 4 per cent. This difference is probably due to the greater amount of leaching out that occurs in the soils of cultivated land.

Locally the Boulder Clay has a different texture—much more sandy. This loamy part is much less calcareous, the lime content averaging about ·8 per cent.

The water-holding powers of these two soils are very different. In the woods both become almost or quite saturated in the winter. The clay, in fact, is often super-

¹ "Journ. Agric. Sci.," ii., 1907.

saturated, the water-table rising to the surface. In summer the clay as a whole always remains moist, while the loam may get very dry.

M. Christy¹ says of the distribution of the two species of *Prinula* that though *P. vulgaris* occurs all round the area occupied by *P. elatior*, the two do not overlap to any extent. In the woods of West Cambridgeshire, however, this sharp distinction does not hold in most cases. Some of the woods have only a single species, but in most the two species occur and largely mixed together. Generally where *P. elatior* occurs it is the more abundant if the soil conditions are suitable.

The factors determining the distribution of *P. elatior* seem to be mainly amount of lime and water content. It does not seem able to flourish if either gets below or above a certain amount, and the range does not seem very great in these woods.

It flourishes most, apparently, on the clay with a lime content of about 4 per cent., and a water content high in spring and never falling much below 30 per cent. at any time of the year. However, it cannot stand a very wet soil: in those woods where the soil remains nearly saturated throughout the year, though the lime content may be quite sufficient, *P. elatior* does not flourish, and *P. vulgaris* takes its place.

Should the soil be drier, again, *P. elatior* ceases to flourish—its lower limit would seem to be about 25 per cent. Thus in some woods and parts of others which have better drainage there are few or no plants of *P. elatior*, but large quantities of *P. vulgaris*.

P. elatior is extremely intolerant of non-calcareous soil. On the loamy patches of the Boulder Clay it is entirely absent, though *P. vulgaris* is present in quantity. The absence in this case is not due to the lowering of water content alone, and in parts of the loam the requisite amount is present at all times of the year, but no oxlips occur.

P. elatior is not a plant that demands a very dense degree of shade. After the coppice in the woods has been cut it increases in quantity very rapidly and flowers with

¹ "J. Linn. Soc.," xxxiii., 1898.

great profusion, while near the end of the rotation of the shrubs it flowers comparatively little and is much less obvious, but responds quickly at any place where there is an increase of light—such as along paths, etc.

With regard to all three factors *P. vulgaris* is much less exacting and has a much wider range of habitats in consequence. It seems very indifferent to lime unless the amount rises too high, as above the chalk, and can flourish in quite non-calcareous soils.

Wherever the two species occur in close proximity hybrids occur in large quantity. These hybrids seem to have a slightly wider range of soil conditions than *P. elatior*, but not nearly so much as *P. vulgaris*. With regard to water content they seem able to flourish in soils too dry for *P. elatior*. But on this point further investigation is necessary.

To summarise, *P. elatior* demands a soil with high water content, especially in spring, but not a saturated soil. This must be combined with a moderate but not excessive amount of lime. Where either of these conditions is unfulfilled, it ceases to flourish and *P. vulgaris* occurs alone, which makes much less demand on the soil.

Other factors certainly come into play in determining the distribution, but in the eastern county woods the above seem the most important.

The flowering season of *P. elatior* is very short: it starts a week or more later than *P. vulgaris* and ceases a considerable time before, and how far this character influences the distribution would make a very interesting study.

CAREX AQUATILIS, WAHLB. AND ITS SCOTTISH FORMS. By
ARTHUR BENNETT, F.L.S.

C. aquatilis, Wahlb., in "Vet. Akad. Handl." (Stockholm), 1803, p. 165.

Richter¹ quotes it as of "Act. Holm.," but the other reference is more easily found.

He gives under it four varieties, but of these *nardifolia*, Wahlb. *l.c.*, belongs to *C. Goodenarii*, Gay, as authentic

¹ "Plant. Europ." i. (1890), p. 155

specimens from Wahlenberg in Boott's herbarium at Kew show.

The first record of *aquatilis* as a Scottish plant was in "Eng. Botany," suppl. t. 2758 (1832): "Found on the Clova range of mountains by W. J. Hooker, W. S. Burchell, and R. K. Greville" (about 1824).

The description was by Dr. Greville, and I have specimens gathered by him in 1831. In Hooker's "Brit. Flora" (1830), p. 398, it appears as *C. rigida*, Good., var. β . In the 3rd ed. (1842), 427, he quotes Boott's doubts as to its being the plant intended by Wahlenberg; but now no doubt is felt, and I have myself seen specimens named by Wahlenberg.

In the year 1851 Mr. J. McLaren read a paper, "Remarks on some British Carices," before this Society, which was also published in the "Botanical Gazette," iii. (1851), pp. 17-27.

In this he suggests three varieties of *C. aquatilis*, but gives them no names. His γ is the nearest we possess to the type plant of Wahlenberg; the habitat he gives is "Glen Isla, and by the bridge at Clova." His β is the Clova tableland plant, and his α comes in between them.

This *Carice* is now known from twenty-three Scottish counties, ten Irish counties, two English counties, and one Welsh county. Yet, in 1860, Hooker and Arnott, in their "British Flora," give only the stations of "the Clova tableland, and in the valley by the bridge at Clova."

One of the most interesting facts with regard to its distribution in Britain is its occurrence in Wales, and Kerry in Ireland, at low levels; yet it is not on record for either Denmark or North Germany. In one of its forms (*C. stans*, Drejer) it extends in Greenland north to 72° N. lat. In Finland it occurs in both Finnish and Russian Lapland to 68° N. lat., and to Nova Zembla.

Though I have tried, it seems impossible to specifically separate our lowland plants from the high northern forms.

In the "Journal of Botany" for June and July 1897, I gave five forms as occurring in Scotland:—

1. var. *cuspidata*, Læstad.
2. „ *virescens*, Anders.
3. „ *minor*, Boott.
4. „ *elatio*r, Bab.
5. „ *epigejos*, Læst. non Fries.

No. 1. *cuspidata*, Læst., in "Vet. Ak. Hand." (1822), p. 339.
 --This is now regarded as a hybrid = *C. aquatilis* × *salina cuspidata*, and I see no reason to doubt this may be so with the Caithness plant, *i.e.* *C. aquatilis* × *kattegatensis*, Fr.; it occurs with the parents on the Wick river, where it was gathered by Mr. Grant.

As I remarked (*l.c.*), I find it difficult to separate it from Læstadius's var. *subacuta* in "Nov. Act. Upsal.," xi. (1839), 289.

As the name *cuspidata* implies, the glumes are drawn out into a long cuspidate point.

2. Var. *virescens*, Anders., "Cyp. Scand." (1849).—Exactly the opposite to the last, the glumes only half the length of the fruit, and the fruits very symmetrically arranged. Perth, B. White!; Spittal of Glen Shee, E. Perth, E. S. Marshall, sp.; Spey bank, Aviemore Co., 96, Messrs. Wilson and Wheldon, 1909; W. Sutherland, E. S. Marshall, sp., Co. Donegal, Hart, sp.; Co. Limerick, Phillips, sp.

3. Var. *spagnophila*, Anders., *l.c.*—He quotes Fries, "Sum. Veg. Scand.," pp. 72, 220, but there is no description there; and "Herb. Nor.," xi., No. 78: "culmo pedali obtusanguli; foliis culmum æquantibus, fructibus squamas acutas pallidas æquantibus; pur viridis."

Swamps on the tableland between Glens Doll, Caness, and Fiagh frequent, 27 6 1904, E. S. Marshall, sp.

4. Var. *clatior*, Bab.! "Man. Brit. Bot." (1843), p. 341: "3-4 feet high, glumes oblong blunt, shorter than the fruit." = var. *Watsoni*, Syme, "Eng. Bot.," 3rd ed., x. (1870), 113.

Some years ago Professor Babington wrote me that "I do not now consider that this is worth a name." Anyhow, it is the largest form we have, and sometimes comes near the original type.

5. Var. *epigejos*, Læst., "Vet. Akad. Hand." (1822), 339 = *C. epigejos*, Hartm. non Fries:—"culmo subpedali, superne scabro; foliis planis strictissimis; bracteis spicem masculum subæquantibus, spicis fem. subarilloribus oblongis, fructibus flavoviridibus, squamis fusco-atris fere brevioribus fusco-viridis." Anders., *l.c.*

In the paper cited I noted that Dr. Ahnquist had named specimens from Methven Bog, Perthshire, as *C. epigejos*,

I there remarked that I doubted this naming, and it has proved a form of *Goodenovii*.

Specimens gathered by the Rev. E. S. Marshall: "By the Spey, below Kingussie, v. c. 96, 1898." On these Herr Kukenthal remarked, "approaches var. *epigejos*, And."

In the "Ann. Scot. Nat. Hist." (1910), p. 50, it is stated that Herr Kukenthal¹ makes *epigejos* synonymous with *C. stans*, Drejer. "Rev. Car. Bor." No. 32 (1841), p. 458. Drejer there says: "Hæc species, ejus perigonia modo immatura vidi, ex distylis *C. aquatili* et *saracili* (*rigida*, Good.) maxime affinis est." Now Hjelt in his "Fl. Fennica" (1895), 270, remarks that Drejer's plant passes for three:—

1. *C. aquatilis* × *rigida*.
2. A small form of *aquatilis*.
3. The arctic *C. stans* of Greenland.

To me Mr. Marshall's specimens belong to No. 2. Neither Richter, *l.c.*, nor Nyman² mention *C. stans*.

6. Var. *forma angustata*, Küken. *l.c.*—From Forfar (Somerville) and East Inverness (Marshall). I have specimens of both these, and how they are to be separated from No. 3 puzzles me. Marshall rightly observes, when these were called *f. gracilis*, "I do not think these are really worth separating."

7. Var. *rigidis*, A. Benn., "Ann. Scot. N. Hist.," Linlithgow; A. Sommerville, sp., 1897.

Kirkcudbright: (1) the Dam, New Galloway, 1887, J. M'Andrew, sp. (2) Kennore Holms, New Galloway, 1887, J. M'Andrew, sp. (3) River Ken, New Galloway, 1884, J. M'Andrew, sp.

In this the male spikes are 2-3, thick, rigid, and adpressed to the stem; female spikes 3-4, stout, continuous, the fruit closely packed, glumes with upper spikes subequal, in the lower often exceeding the fruits, edged with rich brown; middle (broad) green. Stems 2-3 feet high, leaves broad, almost flat, edges very slightly involute.

The habit is much like some *salina* forms, or like a rare Portuguese species, *i.e.* *C. fasciculata*, Link. The stigmas are very long, 3-4 times that of the fruit.

¹ In Engler's "Das Pflanzenreich," *Carex*.

² "Consp. Fl. Europ." (1882), 777.

HYBRIDS.

8. $\times C. hibernica$, Ar. Benn., "Jour. Bot.," June (1897) = *C. aquatilis* $\times$ *Hudsoni* (*stricta*, Good.). Ireland.—Galway's river. Old Kennmore Road. Co. Kerry. 15.6.1889. R. W. Scully.

9. $\times C. Grantii$, Ar. Benn, *l.c.* = *C. aquatilis* $\times$ (*salina*) *kattogataensis*.—By the Wick river, Caithness. J. Grant, sp. 1884. C. L. Marshall, sp., 1900.

10. *C. aquatilis* $\times$ *rigida*.—Sphagnum swamp (2000 ft. alt.) with the parents below corrie of Clova. Forfar. 1904. C. S. Marshall. Lechnagar. Aberdeen. 1851: J. F. (Boswell) Syme, sp.

11. *C. aquatilis* $\times$ *Goodenorii*.—Caness, Forfar; F. W. Miller, sp., 1884: near Spittal of Glen Shee, East Perth. E. S. Marshall, sp., 1906.

The figure of *aquatilis* in "Fl. Danica" supp., t. 33 (1852), seems to come between No. 3 and 4.

In Don's "Herbarium Britannicum," fasc. 8 (1806). No. 492, are specimens of the var. *clatior* of Babington, under the name of *C. stricta*, var.—new species—*Carex*, perhaps only a variety of *stricta*. He says: "I have seen this *Carex* in several places in Scotland, but it is of the rarer species. My specimens were collected from the side of the river Esk, near Eskmount, three miles from Brieren, in Angusshire."

In the "Comp. Cybele Brit." (1870), 589, Mr. Watson mentions that Dr. Boott made out other affinities with forms of *aquatilis*, writing: "in the specimens from the Almond river (near Edinburgh) collected by Professor J. H. Balfour in September 1838, very like *stricta* (Lam.) of America." Thus the *C. Virginiana* of Smith is placed next to *aquatilis* by Bailey:¹ and certainly some of the forms of *aquatilis* do come near to that very variable American species.

¹ "Proc. Am. Acad. Arts and Sciences" (1886), p. 84.

SOME FURTHER MOSSES AND HEPATICS FROM THE ISLE
OF MAY. By WILLIAM EVANS, F.R.S.E.

Since the publication of my list of Bryophytes from the Isle of May in the *Transactions* of the Society two years ago (vol. xxiii. part iv., pp. 348-351), I have paid several further visits to the island and succeeded in finding other seventeen mosses and two Hepatics. These are:—

Polytrichum piliferum, Schreb.—On 17th June 1909 *Polytricha* were met with in some abundance on wind-swept rocky knolls near the lighthouse. Capsules were present though not plentiful. Besides examples referable to *P. juniperinum*, there were others with the long hoary arista characteristic of *P. piliferum* which Mr. Dixon says they undoubtedly are.

Ceratodon purpureus (L.), Brid.—A few patches, bearing old capsules, on old cinder heaps near the lighthouse, September 1910.

Pottia Heimii (Hedw.), Fühnr.—Sparingly, with ripe capsules, at side of path, June 1909.

P. Wilsoni (Hook.), B. and S., sub-sp. *asperula*, Mitt.—Several patches bearing abundance of capsules, some of them already ripe, were found on 23rd September 1910, where a little soil had collected on the rocks at the south-east corner of the island.¹

Tortula muralis (L.), Hedw.—A little on rock at the lighthouse, September; fruit scarce.

Barbula rubella (Hoffm.), Mitt.—Common on old track, June 1909; barren.

Funaria hygrometrica (L.), Sibth.—On the path near the lighthouse, common and fruiting freely, June 1909; also on old cinder heaps, September 1910.

¹ Regarding this moss—perhaps the most interesting I have found on the island—Mr. Dixon writes me as follows: “Your *Pottia*” (which I sent to him as *P. Wilsoni*) “is rather puzzling; it is quite easy to run it down by the key to *P. asperula*, for it has the larger cells of that as compared with *P. Wilsoni*, and quinquefarius leaves; but then the capsule is more elongate, rather. The rough calyptra seems to place it without doubt under *P. Wilsoni* or *P. asperula*, and the two are very close to one another, scarcely, I think, separable. I do not think you can be very far wrong in calling it *P. asperula*, in spite of the fact that that has been only found in the south hitherto.”

Bryum capillare, L.—A few small barren tufts on a moist rock near the lighthouse, September.

B. atropurpureum, W. and M.—A few plants, bearing old capsules, growing among the *Ceratodon*.

B. argenteum, L.—A little coming up on the track near the harbour, June 1909.

Camptothecium sericeum (L.), B. and S.—On damp rock near the lighthouse, September 1910.

Brachythecium plumosum (Sw.), B. and S.—A little among *Grimmia maritima* on rocks. Determined by Mr. Dixon.

Plagiothecium undulatum (L.), B. and S.—Two large patches in hollow near the low lighthouse, September 1910.

Hypnum polygamum, Schp. ?—A *Hypnum* gathered in a marshy spot on 14th July 1910 is, Mr. Dixon considers, probably this species, although somewhat abnormal. It must, I think, be a state of this moss.

H. fluitans, L.—Abundant in small pools on the higher ground south of the engine-house, June 1909 and subsequent dates.

H. resupinatum, Wils.—Sparingly on rocks near south end, July 1910.

H. cuspidatum, L.—In damp hollow on east side, August and September 1910.

Plagiochila asplenoides (L.), var. *humilis*, Nees.—Sparingly on rocky bank near south end, July 1910.

Lophocolea cuspidata, Limpr.—In same situation as the last; with inflorescence. Determined by Mr. Macvicar, who has also examined the *Plagiochila*. Other specimens of *Lophocolea* growing among grass may have been *L. bidentata*, but no inflorescence was found by which to decide.

In a recent part of the *Proceedings of the Royal Society at Edinburgh* (vol. xxx., part ii., published in January 1910), Mr. George West mentions twelve Bryophytes observed by him on the Isle of May during a visit to it in August 1905. Some of these have not, so far, come under my notice. In June, and again when staying on the island in September, this year, I looked in vain for *Lunularia* in the cave where Mr. West states he saw it growing in 1905. *Cono-*

cephalum, also mentioned by him, was there in profusion, and in all stages of growth.

The present instalment brings the number of Bryophyta I have collected on the May up to forty-four: *i.e.* Musci thirty-five, and Hepaticæ nine. Several of the species recorded in my former list were this year met with in other spots, showing them to be more common than I had thought. I have again to thank Messrs. Dixon and Macvicar for kindly examining a number of my specimens.

SUPPLEMENTARY NOTE ON MOSSES OF PRINCE CHARLES
FORELAND, SPITZBERGEN. By H. N. DIXON, M.A.,
F.L.S.

A small packet of mosses collected on the above island was put into the hands of Mr. J. Hunter by an assistant who accompanied Dr. Bruce on the expedition of 1906-7. These Mr. Hunter handed to me for examination, with the remark that they were sent just as he had received them, and consisted only of four or five species probably, with apparently very little interesting about them except in so far as they came from a hitherto unexplored tract. On examination I found that about eight species were represented, mostly of the usual arctic type. Not being aware that the mosses of the expedition to this island were being worked out by Dr. Hagen, I was satisfied with determining the species, and it was not till Dr. Hagen's article appeared in the *Transactions* (xxiii., p. 326, 1908) that I became aware of it. Had I known this to be the case, I should of course have communicated the results of my examination of these specimens to him, in order that they might be incorporated in his list.

Since my list includes one or two forms not recorded in Dr. Hagen's account, and therefore new to Prince Charles Foreland, it seems worth while to supplement that account by publishing their names. I give the full list, marking with an asterisk those which are not included in Dr. Hagen's article.

Aulacomnium palustre, Schwaegr. -In quantity.

**A. tardidum*, Swaegr.—A stem or two of this typically arctic species occurred.

Polytrichum alpinum, var. *brevipodium* (R. Br.) Brid.

Hypnum acinatum, Hedw.—In two forms: one which I labelled "a rather short dense form" may no doubt be referred to the var. *abbreviatum*, B. and S. The other I had determined as var. *orthothecioides*, Sindb., but it is no doubt the var. *fœneum* described by Dr. Hagen.

**Hypnum revolvens*, Sw.—A few stems, with *H. sarmentosum*.

H. sarmentosum, Wahl.—A short form, very probably the same as that described by Dr. Hagen.

H. stramineum, Dicks.

**H. badium*, Hartm.—A stem or two, with *H. revolvens* and *H. sarmentosum*.

with a certain amount of sand and silt. The stones are of all sizes, very large ones, and indeed rocks, being quite common. They are arranged most unevenly, though the general surface is flat. Such a soil is deficient in available nutritive salts, and in itself provides merely desert conditions for plant-life, no matter how frequent the downpour. With the drying of the river-bed, and especially of those parts liable to frequent submersion, the silt, which is composed of very fine particles, is moved by quite a gentle breeze, while, during the frequent gales, it, together with the finer sand, is deposited in the lee of rocks and caught by the vegetation. The silt supply being constantly renewed by floods, the amount of light soil which is conveyed by the wind to the old flood-plain is very considerable and has led to a thin coating of light silky loam which, though far from being a fertile soil, is quite sufficient to support, with the addition of the self-supplied humus, a closed formation of those plants which are provided with certain "adaptations."

The stony soil is porous to the extreme: the shallow silty soil, too, dries rapidly, and its water-content is usually small. But the frequent rain renders the surface wetter than might be expected, and the humus, which finally becomes an important constituent, is able to absorb and hold abundant water. Beneath the surface, just under the top layer of stones, the soil is generally more or less moist, the stones hindering evaporation. The larger stones and rocks also play an important part in checking evaporation, both from the shelter from wind and the shade from sun which they afford. These aids towards conserving the rain-water are of special importance, since, as will be shown, it possibly forms the chief water-supply of the plants.

There is obviously no lack of underground water, the water-table, except in winter, lying very near the surface, the distance, however, depending on the height of the older flood-plain and the distance from the sides of the valley. This abundance of water arises from the fact that the streams of the river, numerous and rapid though they are, represent only a small portion of the actual river-water, so porous are their beds; in fact, the greater part

of the river's flow is subterranean. The presence of the underground stream makes itself plainly visible in flood-time through the rapid formation of new streams and the filling of dry channels, while, on the other hand, a diminution of the supply, as in winter, may cause the suppression of the streams altogether. A river-fan is frequently quite dry, yet at its termination streams gush forth. Similarly, some river-beds are normally without surface-water in one part, while in another, higher up, there will be a rapid stream which, all on a sudden, disappears beneath the surface.

The river-water, issuing as it does from the ice, and in large part the result of its melting, is, at most, but a few degrees in temperature above the freezing-point, and is therefore of little moment for plant-life. Nor can the underground stream be much warmer. *A glacial river-bed, then, near its source, appears to be both a physical and physiological dry station.* The physical dryness seems in itself sufficient to govern the plant-life, since far from the river's source in the lowlands, where the river-water is much warmer, the plant-life is very similar in character, many species being identical, as well as growth-forms; indeed, on the whole, the subalpine river-bed, owing partly to its more abundant rainfall, is the less xerophytic station of the two. In winter, when the streams dry up more or less, the subterranean water must be considerably lowered, and lie beyond the reach of most of the plants.

How far the heat from the sun can penetrate into the soil I cannot say, but probably to no noticeable depth, except between the chinks of the stones. These latter become so strongly heated during a period of insolation that one can hardly bear to touch them with the hand, and the reflected heat must be very considerable so far as the ground plants are concerned. On the other hand, the stones rapidly lose their heat when the sun's rays are obscured.

As for aeration of the soil, that will be abundant.

From the above it is evident that a river-bed is a strongly xerophytic station, and that, notwithstanding an abundant rainfall, the conditions primarily resemble those of a desert.

4. GROWTH-FORMS.

(a) GENERAL.

In order to understand the all-important relations of the plants to one another a knowledge of their growth-forms is essential, since on their humus-making capacities, power of affording shelter, germination facility, vegetative increase, root-systems, xerophytic structure, and so on, depends almost entirely the sequence of events. In other words, though the first colonists are those fortuitously brought by various agencies from the comparatively rich flora of the neighbourhood, only those suited to the severe ecological conditions can gain a footing in the first place; but afterwards it is the growth-forms of the plant-colonists themselves which finally, or at anyrate equally with soil and climate, determine the character of the associations and the procession of events.

(b) SYNOPSIS OF SPECIES ACCORDING TO THEIR GROWTH-FORMS.

A.—*Low Trees*.

(a) Summergreen.

*Gaya Lyallii*¹ (Hook. f.), J. E. Baker (branches slender, somewhat fastigate; leaves bright-green, not thick).

(b) Evergreen.

Phyllocladus alpinus (2), Hook. f. (trunk slender; cladodes thick, coriaceous).

B.—*Shrubs*.

(a) Leafless (more or less).

* Summergreen or partly so.

(1) Shoots frequently reduced to spines.

Discaria tomentosa, Raoul. (erect, 60 cm.—4·5 m. tall; branches numerous, divaricating; leaves small; young stems and spines green; roots long).

(2) Shoot-axes green, assimilating organs.

Carmichaelia grandiflora, Hook. f. (erect or decumbent,

¹ Also shrubs.

30–60 cm. tall or less; leaves ternate or pinnate: leaflets 1.2 cm. $\times$ 8 mm.; roots long).

* Evergreen; leaves scale-like.

Helichrysum depressum (Hook. f.), Benth. and Hook. (erect, little-branched, rigid, spreading: about 43 cm. tall $\times$ 20 cm. through: scale-leaves very small, adpressed to stem few; woolly; root very long).

(b) Leafy, evergreen.

* Erect.

(1) The divaricating form.

Coprosma rugosa, Cheesem. (leaves narrow-linear).

§ Leaves small, coriaceous.

Coprosma parviflora, Hook. f.

C. propinqua, A. Cunn. (?)

Aristotelia fruticosa, Hook. f.

(2) The tree-composite form.

Leaves coriaceous, tomentose on under surface.

Olearia ilicifolia, Hook. f. (leaf with spinous margin, musk-scented).

O. avicenniæfolia, Hook. f.

Senecio elaeagnifolius, Hook. f.

(3) The ball-like form.

Veronica salicifolia, Forst. f. (branches not dense: leaves about 7 cm. long).

V. subulpina, Cockayne (dense-growing: leaves 2.5 cm. long, more or less).

** Creeping or depressed.

(1) Stems rooting.

§ Prostrate stem subterranean.

† Erect.

Styphelia Fraseri (A. Cunn.), F. v. Muell. (3–10 cm. tall; stems slender, wiry; leaves small, stiff, pungent, imbricating).

Lycopodium fastigiatum, R. Br. (7.5–9 cm. tall; stems slender, stiff; leaves small, thick, often yellowish).

++ Prostrate.

Muchlenbeckia arillaris, Walp. (mat-former; stems slender, wiry; leaves small, thick).

§§ Prostrate stem above ground.

Coprosma brunnea (T. Kirk), Cockayne (stems stout, rigid; leaves narrow-linear, very small; root very long).

(2) Stems not rooting.

Pimelea laevis, Gärtn., var. *repens*, Cheesem. (stem spreading, flexible, forming a loose mat; leaves small, thick, glaucous).

C.—*Lianes*.

(a) Scrambler (climbing by hooked prickles or midribs).

Rubus schmidelioides, A. Cunn., var. *coloratus*, T. Kirk (leaves coriaceous, 3-5 foliate; leaflets flat, tomentose beneath).

(b) Pendril-climber.

Clematis australis, T. Kirk (stem slender; leaves much divided, subcoriaceous).

D.—*Herbs and sub-shrubs*.

(a) Summergreen.

Subterranean stem creeping; aerial erect.

Coriaria ruscifolia,¹ L. (aerial stem woody; leaves moderate-sized, thin).

C. thymifolia, Humb. and Bonpl. (aerial stem succulent; leaves small, thin).

C. angustissima, Hook. f. (aerial stem succulent; leaves very narrow, small, thin).

(b) Evergreen.

* Spot-bound.

(1) The rosette-form.

Geranium sessiliflorum, Cav. (rosettes form small, round patches flattened to the ground about 7 cm. in diameter; leaves orbicular, about 1.2 cm. in diameter, moderately thick, covered with silky hairs).

¹ In many situations *C. ruscifolia* is a true shrub or even a small tree. It is probable more than one species is included under the name.

Ranunculus lappaceus, sm. var. *multiscapus*, Hook. f. (rosette small, open; leaves moderately thick, hairy).

Viola Cunninghamii, Hook. f. (Rootstock stout, sub-woody; rosettes open, leaves thin).

Craspedia uniflora, Forst. f. var. (rosettes open, often several together; leaves spathulate, 10 cm. or more long, semi-erect, woolly).

Angelica Gingidium (Forst. f.), Hook. f. (rosette large, open; leaves pinnate, 15 cm. or much longer, thick, coriaceous, waxy beneath; root long, fleshy).

(2) The erect, tufted form.

§ Woody, more or less.

Stem erect, wiry, woody at base, about 14 cm. tall; leaves moderately thick, coriaceous.

Epilobium melanocaulon, Hook. (stem black, leaves reddish).

E. glabellum, Forst. f. (leaves often reddish beneath).

§§ Not woody.

° Grass-form.

‡ Leaves narrow.

Festuca rubra, L. var.

‡‡ Leaves broad, flat.

Trisetum Youngii, Hook. f. (leaves pilose).

Luzula campestris, D.C. var. (leaves coriaceous).

°° Tussock-form.

Poa cuspidata, Forst. f. (tussocks 30 cm. tall and more; leaves filiform involute).

Poa Colensoi, Hook. f. (tussocks small, leaves very narrow, involute).

** Creeping and rooting.

(1) The cushion-form.

§ True cushions.

Raoulia Haastii, Hook. f. (glabrous or nearly so).

R. glabra, Hook. f. (glabrous or nearly so).

§§ Semi-cushions or round patches.

Raoulia lutescens (T. Kirk), Cockayne (tomentose)

R. australis, Hook. f. (tomentose).

(2) The mat-form.

§ Stems suffruticose.

The species of *Acaena* (leaves thin, more or less silky).

Helichrysum bellidifolius (Forst. f.), Willd. (stems slender, much-branching, leaves small, flat, tomentose beneath).

Veronica Bidwillii, Hook. f. (stems much-branching, wiry; leaves very small, thick, glossy).

§ Stems herbaceous.

° Leaves tomentose.

Helichrysum pilicula, Hook. f. (aerial stems, very slender, hardly branched, about 6 cm. tall).

Gnaphalium Traversii, Hook. f. (leaves in rosettes which form close patches).

°° Leaves pilose.

Cotula squalida (stems slender, far-creeping; leaves deeply-cut, in open rosettes).

°°° Leaves glabrous or nearly so.

Asperula perpusilla, Hook. f. (stems filiform, leaves very small, thin).

Hydrocotyle nova-zealandica, D.C. var. *montana*, T. Kirk (stems comparatively stout, matted; leaves small, coriaceous).

Pratia angulata (Forst. f.), Hook. f. (stems rather fleshy; leaves small, moderately thick).

Uncinia divaricata, Boott (leaves grass-like, flat, somewhat rigid).

Wahlenbergia saricola (R. Br.), A., D.C. (leaves in open rosettes about 15 mm. in diameter, thick, coriaceous).

Poa anceps, Forst. f. var. (leaves sub-coriaceous, concave, tufted).

(c) THE RAOULIA-FORM.

Several species of *Raoulia* (compos.), a genus consisting of seventeen endemic and one or two Australian species, are so characteristic of river-beds, and their growth-form plays such an important rôle in the evolution of the vegetation, that some special details seem necessary.

The New Zealand species are either patch- (frequently circular-), or cushion-plants, but in this case both growth-forms are constructed in exactly the same manner, inter-

mediates between them exist, and the difference of one from the other is of degree merely.

There is a central woody main stem and a deeply-descending chief root. From near the base of the stem a number of prostrate and rooting branches pass off radially. These branch abundantly in their turn, the divisions having a tendency to grow upwards, and this is assisted by the frequent branching and consequent increasing density hindering their horizontal extension. This closeness of growth, too, shutting off the light, causes the death of all the interior leaves and many of the stems, so that only the stouter persist, the interspaces becoming filled, in the case of the thicker cushions, with peat, and in that of the patches and low cushions with wind-blown silt. According to the relation between the rate of horizontal spread and vertical growth are patch-plants or cushions produced.

The leaves are small, generally more or less imbricating, and very frequently tomentose. The ultimate shoots are sometimes pressed so closely together that they form a hard and unyielding surface, as in the case of the various "vegetable-sheep" (*R. crinita*, *R. Goughii*, etc.). When large quantities of peat (raw humus) are stored up within the cushion, the upper branches put forth adventitious roots by means of which the plant gets most of its water and salts, the main root serving chiefly as an anchor.

Raoulia Haastii, the most important species of the sub-alpine river-beds of much of the Canterbury and Westland Southern Alps, forms bright green cushions of considerable dimensions, that shown in the photograph (Plate X.) measuring 68 × 57 cm. There is a stout, woody main stem and branches. The leaves are crowded near the ends of the ultimate branchlets, the leafy part of the shoot being about 9 mm., or even less, in length. They are glabrous, coriaceous, and the base is sheathing; the sides of the blade are bent upwards, making the upper surface concave. A cross section of the cushion shows a very narrow green zone of living leafy shoots, a second rather wider brown zone of stems with dead leaves attached, a third 4–5 cm. deep or more, with many of the branches and leaves turned into peat, but not fallen away, a fourth where the peat has fallen away from the stems and where the

bare shoot-axes have put forth roots, and the fifth, the final zone, which consists of creeping and rooting stems. These latter only give off roots in relation to wet soil, as when growing on silt or peat, since they are quite rootless when extending on a bare rock-surface.

The species of *Raoulia* show an interesting epharmonic gradation of forms from the rapidly-growing creeping patches or mats of *Raoulia tenuicaulis*, with its open mesophytic leaves of seedlings and reversion-shoots, to the highly differentiated dense woolly masses of the vegetable-sheep (*R. eximia*, etc.), denizens of wind-swept and sun-scorched alpine rocks: and it is easy to see how the present species have been evolved from mesophytic creeping herbs by xerophytic conditions arising from migration to xerophytic stations, or, what is more likely, in the first instance, a dry climatic period.

5. THE PEOPLING OF THE RIVER-BED.

(a) GENERAL.

The peopling of the river-bed, which station, it must be remembered, is absolutely new ground, resolves itself into several distinct stages, each of which is really a valid plant-association, always present on the river-bed, and although, like any presumed stable plant-formation, capable of change, is just as much a regular feature of the landscape as is a forest.

(b) THE UNSTABLE BED (*Epilobium Association*).

On that part of the river-bed subject to occasional flooding there are, at wide intervals apart, occasional plants, about 16 cm. tall, of *Epilobium melanocaulon* (Onagrac.), conspicuous through its dark purple stems and usually reddish leaves. The wind-borne seeds, their rapid germination and the quick growth of the seedlings, enable this species to speedily establish itself. Although the station is fully exposed to the wind, the stones offer abundant protection to the quite tender young plants, and this applies to every part of the river-bed. Their roots, although short, will quickly reach the water under the uppermost stones, and this will frequently be much warmer than that of the

actual river. In a few places there are the silvery mats, 40 cm. in diameter, more or less of *Raoulia tenuicaulis*, the most rapid-growing of the species, thanks to its heterophylly and the more mesophytic reversion-shoots. The low mat-form (patch-form) of the plant offers a minimum of resistance to the wind, its tomentose leaves check transpiration, its numerous short adventitious roots can secure the warmer water, while its descending main root serves as an anchor. Other species of *Raoulia* present, but much fewer in numbers and with similar "adaptations," are *R. australis* and *R. glabra*.

If this pioneer colonisation has taken place on a part of the bed liable to flood, it can proceed no further, but if the ground remain dry enough, or a change towards dryness comes about, then other plants arrive and the second phase of colonisation begins.

On many river-beds, especially in the drier localities or by the sides of mountain torrents, the *Epilobium* association is more important than that just described. *E. glabellum*, of a similar growth-form to *E. melanocaulon*, being especially abundant, while mats of *E. pedunculare* will be everywhere, and the beautiful *E. macropus* where shallow still-water lies.

(c) STABLE RIVER-BED.

a. *Raoulia* Association.

When for some reason or other a portion of the river-bed has got quite beyond the influence of floods, as when a stream has receded or terrace-building has provided a dry station, then there is a gradual procession of events. First of all, a dark-coloured crustaceous lichen coats the stones large and small, *Epilobium melanocaulon* and *Raoulia tenuicaulis* appear, and are rapidly reinforced by *R. lutescens*, *R. australis*, *R. glabra*, and, above all, by *R. Haastii*, which soon becomes dominant and gives a striking character to the association through the presence everywhere of its great green cushions, which grow either singly or merge into one another. Nor are they confined to the flat surface of the river-bed and the small shingle, but they spread over the larger stones and even rocks, conforming to

the irregularities (see Plate XI.). While being raised up, and the supporting rock hidden, the cushion appearance becomes still more marked.

As for the other species of *Racomitria* mentioned above they are fairly common, though not nearly so abundant as on montane or lowland river-beds of the drier localities. The hoary xerophytic moss *Racomitrium lanuginosum*, forming small cushions, or patches, is extremely abundant and of physiognomic importance: indeed it is almost the first-comer on ground beyond the reach of floods. This moss becomes exceedingly dry during fine weather, and the long hyaline points to the leaves are pressed against the shoot and so much increase the hoary appearance, since when wet the leaves expand, are held semi-horizontally, and the points project outwards. A yellow, low-growing moss, which also dries rapidly, is very common, occupying the chinks between the stones. Small colonies of a white fruticose lichen, a species of *Cladonia*, are here and there.

Another common plant of this early stage is that very curious grey-coloured shrub, *Helichrysum depressum*, looking, with its rigid stems and few scale-like grey leaves, even when at its best, more than half dead.

As soon as these early xerophytes are established, other plants make their appearance, the "seeds" brought by the wind or other agencies: but, generally speaking, they cannot thrive upon the stony ground, and, with certain exceptions, those alone gain a footing whose seeds light upon the cushions of *Racomitria Haastii*. There, thanks to the abundant moisture contained within the cushions, and to their peat-content, the seeds germinate and the young plants thrive. On one cushion, and this was a fair average, the following were present: small plants of *Poa Colensoi* (Gramin.), small rosettes of *Wahlenbergia saricola* (Campan.), some *Styphelia Fraseri* (Epacrid.), *Hydrocotyle norae-zelandica* (Umbell.), its leaves pressed closely to the cushion, *Microtis uniflora* (Orchid.), stunted *Lycopodium fastigiatum* (Lycopod.), and a few small woolly rosettes of *Craspedia uniflora* (Compos.). The "seeds" of these and other plants falling upon the *Racomitria* cushion are firmly held between the shoot-apices, while the frequent rain

favours their rapid germination, upon which the root easily reaches the water-supply at a few millimetres beneath the surface of the cushion.

It is easy to see that as the epiphytes on the cushion increase in size they cut off the light-supply from its leaves, which are none too many on each stem at best, and the *Racomelia* dies piece by piece, leaving behind it a deep layer of humus. Since there are large *Racomelia* cushions dotted everywhere at a distance apart of 30 cm. or so, while fresh cushions are continually becoming established on the intermediate stony ground, it is evident that what was originally an edaphic desert may be rapidly converted into fairly fertile ground by the agency of *Racomelia Haastii* alone, aided by the abundant supply of moisture. The xerophytic moss *Racomitrium lanuginosum* also plays some part as a humus-former, as do likewise the other species present of *Racomelia*, especially the quite low but dense silt-holding cushions or patches of *R. lutescens*.

In addition to the species already noted, certain others early on occupy the stony ground between the cushions, though these latter still remain dominant. Amongst these early comers are: *Veronica Bodwili* (Scrophular.), which forms on the stones open green mats of slender, wiry, creeping stems and short leafy branches; *Styphelia Fraseri*, in broad brownish patches, the short erect wood stems raised 3 cm. above the stones; *Coprosma brunnea* (Rubiace.), with stiff prostrate woody stems; *Muehlenbeckia axillaris* (Polygonac.), forming round patches, its slender, almost black wiry branches flattened to the ground and the small yellowish-green leaves almost touching but held nearly vertically; *Wahlenbergia saricoides*, with its small open rosettes and, in their season, rather large white flowers; *Geranium sessiliflorum*, in small circular patches made up of several rosettes flattened close to the stones and small tussocks of *Poa Colensoi* (Gramin.). As the last-named increase in numbers, the tallness and density of this growth-form giving it an advantage over the creeping plants, etc., the species, by degrees, becomes very common. Also it adds further humus to the soil by its decay, and

at the same time the wind-borne silt and sand is caught and held, so that, by degrees, the stony substratum becomes the sub-soil. On the other hand, the upper layer, formed altogether through the action, direct and indirect, of the vegetation, will consist of silty loam mixed with humus, averaging perhaps 5 cm. in depth, or even more, becoming capable of supporting a closed plant-covering of a steppe character.

β. Steppe.

The absence of bare spaces between the plants, the dominance of the tussock-form and the presence of many of the species of the *Raoulia* association, together with a number of others, defines the steppe association.

The association is not altogether virgin, since sheep, hares, and red-deer graze upon the herbs and shrubs, but this has affected luxuriance of growth rather than brought about any fundamental change.¹

Poa Colensoi is, in many places, the chief tussock grass, the individual plants sometimes growing closely together and excluding other vegetation. Where the upper soil is deeper, the much more robust *Poa caespitosa* is plentiful, and the character of the association is then that of ordinary tussock-steppe. *Poa anceps* var. is also a common grass in some parts: it does not form erect tussock, but the culms and leaves are more or less prostrate, and form a thick mat which may contain much dead matter and is then a soil-maker. But this grass plays a more important part on the firmer debris-fields ("shingle-slip") of the adjacent slopes. Between the tussocks, and benefiting from the shelter these give, there are patches of *Styphelia Fraseri*, small mats of *Coprosma brunnea*, dwarfed *Carmichaelia grandiflora* (usually much eaten by hares and sheep), *Hydrocotyle novæ-zelandiæ* growing close to the ground, *Luzula campestris* var. (Juncac.), *Craspedia uniflora* var., *Lycopodium fastigiatum*, *Ranunculus foliosus*, *Asperula perpusilla* (Rubiace.), considerable round patches of *Coriaria thymifolia* and the feathery *C. angustissima* (Coriariace.), abundance of *Pimelea loricata* var., *repens*

¹ The presence of grazing animals, by reducing the amount of shelter, is favourable to steppe and antagonistic to forest.

(Thymeleac.), occasional plants of *Angelica Gingidium* (Umbel.), with its tufted, coriaceous pale-green leaves, small colonies of *Veronica Bidwillii*, the grasses *Festuca rubra* var., and *Hierochloa Fraseri*, *Geranium sessiliflorum*, *Wahlenbergia saxicola*, and *Viola Cunninghamii*.

Raoulia Haastii cushions are still present, but in much smaller quantity, but their remains in various stages of decay are, in places, much in evidence. On the oldest river-bed there is abundance of *Acaena Sanguisorba* var. *pilosa* (Rosac.) and *A. inermis*, and as the scrub is approached *Geranium microphyllum* becomes extremely common.

As for erect shrubs, plenty of stunted *Coprosma rugosa* is dotted about, and the spiny *Discaria toumatou* (Rhamnac.) is frequent in many places.

γ. Scrub.

Scrub is the final association, so far as the river Rakaia is concerned. On other river-beds *Nothofagus* forest may be the climax, but it is generally on slopes or the summits of high terraces that forest occurs.

The scrub is simply subalpine scrub which has descended to the river-bed, and so needs no detailed description. It consists of: *Gaya Lyallii* (Malvac.), *Olearia ilicifolia*, *O. arvicuniifolia*, *Senecio chaquifolius* (Compos.), *Phyllocladus alpinus* (Paxac.), *Coprosma propinqua* (?), *C. rugosa*, *C. parviflora* (Rubiace.), *Discaria toumatou* (Rhamnac.), *Veronica subalpina*, *V. salicifolia* (Scrophular.), and *Coriaria racemosa* (Coriariac.). As lianes there are *Rubus schmidelioides* var. *coloratus* (Rosac.) and *Clematis australis* (Ranun.).

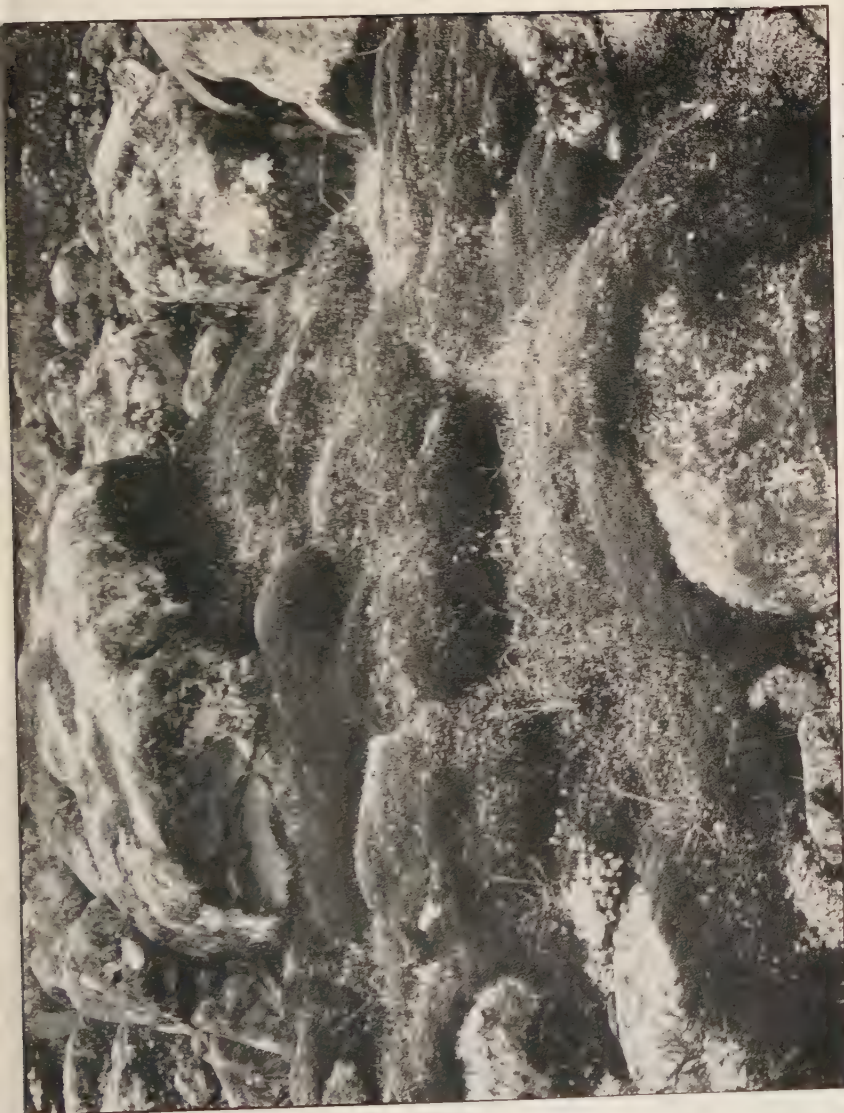
Discaria scrub, or perhaps better *Discaria* steppe, is quite distinct from the above. It frequently occurs at a much lower elevation, and probably is not a phase of the succession, as here described, but a primary formation depending on a certain stability of the river-bed. It is especially plentiful on the fans of tributary streams, and makes quite a dense scrub not easy to penetrate on account of its formidable thorns. *Discaria* is the sole component; the dark colour of its stems and its few leaves render the association conspicuous, even from a distance.



General view of the Rakaia river-bed. Ground liable to flood in foreground. Terraces being built in centre, and behind is terminal face of the Ramsey glacier. (Photo., R. Speight.)



Source of River Rakaia. Moraine-covered terminal face of Lyall glacier in centre. (Photo., M. C. Guder.)



Irregular cushion of *Raoulia Huastii*, 68 cm. x 57 cm. The white patches are the moss *Racomitrium lanuginosum*, 4 cm. deep. River-bed of Rakaia. (Photo., L. Cockayne.)

(d) AFFINITIES OF THE RIVER-BED ASSOCIATIONS.

The river-bed, prior to its peopling, is more closely related to shingle-slip than to any other land-form. It differs ecologically in its flat surface, stability of the substratum, and greater amount of surface-moisture, whereas the stones of the shingle-slip are always liable to move while the rain-water will pass off more rapidly. The consequence is that, contrary to expectations, true shingle-slip and river-bed have virtually no species in common, those of the former land-form being highly specialised and confined, or nearly so, to moving débris as their station. Where, however, large stones fill the bottom of a shallow gully and are fairly stable, certain species of *Raoulia* may be present (*R. tenuicaulis*, *R. australis*, *R. lutescens*), but *R. Haastii* is invariably absent, so it is possible that the first three-named species may tolerate a certain amount of burial, whereas it may be the intolerance to this which confines the plant in question to the river-bed, since its "seeds" must constantly be blown on to the bare mountain slopes.

The subalpine river-bed *Raoulia* association is closely related to that of the lowlands and of the mountain steppe-climate, both ecologically and floristically, but in the lowlands *Raoulia Haastii*¹ is wanting; and as the other species of the genus do not nearly so much favour the presence of epiphytes, owing to the absence of peat within the cushions, or supply so much humus by their decay, the advent of tussock-steppe is a slower process.

The steppe is floristically and ecologically related to that of the drier mountain slopes, but is made up of fewer species. Some of its plants, however (e.g. *Poa anceps* var., *Carmichaelia grandiflora*, *Coprosma rugosa*), do not generally occur except where there is an abundant rainfall.

The scrub association, as already noted, is almost identical with the subalpine scrub of the immediate neighbourhood, and the *Discaria* thickets have their counterpart on lowland river-beds and sand-dunes, and may be considered a form of steppe rather than subalpine scrub, which latter is a mark of a forest-climate.

¹ In Westland *R. Haastii*, thanks to the wet climate and proximity of lofty mountains, descends to at least 300 m. altitude.

MITES AND ACARODOMATIA.

By Professor G. F. SCOTT-ELLIOT, M.A., B.Sc., F.L.S.

A Swedish botanist, Lundström (1), published in 1887—now a very long time ago—a classical paper upon mites and their dwelling-places, or, as he called them, acarodomatia. It was then a new subject, and the article, deservedly, attracted a great deal of attention. It is seldom that an original research is not only thorough, exhaustive, and exactly careful in details, but is also both suggestive and extremely interesting.

Quite a number of other botanists began to observe mites and look out for acarodomatia during the next few years. Then, however, followed an interval during which I have not met with any papers on the subject. Since 1903, however, several Italian and other botanists have been studying mites, and the attention of British botanists should be directed to this interesting subject.

The mites are a well-defined and strictly limited class of insects, and yet within the group there is an astonishing variety not only in structure but also in habit of life.

To the mites belong *Tetranychus* (red spider), *Phytoptus* (the currant mite), and *Tyroglyphus*, which are amongst the very worst vegetable parasites known to us. Certain mites are parasites on animals and birds, such as that which forms scabies (or itch) in man. Others live on the feathers of birds. Some live almost entirely in water, and many are saprophytic. Others, again, are active and nimble hunters, true carnivorous animals preying upon all sorts of minute insects.

The particular group of which I wish to speak includes especially two species, *Tydeus foliarum* and *Gamasus* spp. I am not a sufficiently good entomologist to be able to say anything about the classification of these mites, and I am not sure if those names still hold. What has interested me most has been their ways of life and their part in the economy of the vegetable world, and it is under these names that they are mentioned in botanical literature.

These particular mites are exceedingly common, as one soon realises when beginning a systematic search for them.

TRANSACTIONS
OF THE
BOTANICAL SOCIETY OF EDINBURGH.
SESSION LXXV.

PRESIDENTIAL ADDRESS.

LADIES AND GENTLEMEN.—In rising to address you from the Chair on the occasion of the opening of the seventy-fifth session of the Botanical Society of Edinburgh, it is perhaps hardly necessary for me to offer you an apology for the fact that these remarks of mine cannot be on a scientific subject connected with botany, because you all know that I am not a man of science, far less a scientific botanist qualified to take up and deal with a botanical subject in a manner worthy of this learned Society. All the more, then, I have felt it a very great honour that you should have permitted me, a mere lover and a mere grower of plants and flowers, to preside over your meetings for two sessions, and to do what little has been in my power in taking an interest in the work and the welfare of the Society. My remarks to-night, then, can only deal with the position of the Society, and the changes that Time has brought upon us, and the work which, as a Society, we have, during the past session, been enabled to do.

In the first place, it is right that I should refer to the loss sustained by the Society in the death of its Patron, King Edward VII. As you will remember, an address of condolence to King George V. was submitted and directed to be sent to the Secretary for Scotland. Due acknowledg-

ment of this was received in July last, and that was duly communicated to you, his Majesty having been graciously pleased to receive and to thank the Society for their expression of sympathy and loyalty. It will, I am sure, be your wish that the Council should take such steps as may be necessary to endeavour to secure the patronage of his Majesty King George in succession to that of his revered father.

Turning, then, to the position of the Society as regards its membership, we have during the past year added to our numbers 4 Resident Fellows, 1 Non-Resident Fellow, and 1 Lady Member, making a total of 6 added to our number. But, on the other hand, death has removed 2 Foreign Fellows, 3 Resident Fellows, 1 Non-Resident Fellow, and 1 Associate—a total of 7, while 4 Resident Fellows of the Society have resigned their membership. This involves a net loss of 5 in our numbers. I had fain hoped that I would not have had to report to you a reduction of membership, but there it is: and it is for us members of the Society to do what we can in the coming session to bring within our membership some of the many who, in these times, are interested in botanical science, either from a popular or a scientific standpoint. As a Society we have, during the past session, made certain changes in our laws which will enable us to bring into the Society a class of Ordinary Members—ladies or gentlemen—who, though not desiring to become Fellows of the Society, may obtain the advantages of membership on reasonable terms, and many of whom, we hope, may later on become Fellows of the Society, and so recruit our ranks in that respect. I am glad to think we are already making a commencement in the election of this class of member.

Although the coming number of the "Transactions" of the Society will not be a bulky volume, I think we may consider that it will record and contain a considerable amount of interesting botanical information, which will make it a useful work of reference. I might mention particularly the communications from Mr. Arthur Bennett on the genus *Carex* in Great Britain, and the notes on rare Mosses by Mr Evans, and by H. N. Dixon. But besides this there has been published, since we last met, a very

important botanical work—as Volume XXV. of the “Transactions and Proceedings” of the Society—“The Distribution of Hepaticæ in Scotland,” by Mr. Symers A. Macvicar. This volume has been issued to the Fellows of the Society and to the various bodies with whom we exchange publications. While the Hepaticæ are perhaps not a race of plants which appeal to all classes of botanical students, those of you who have had time to examine this work cannot but be convinced of its great importance as an addition to botanical literature and science, and you cannot fail to be impressed with the immense amount of research and work which Mr. Macvicar has devoted to his subject. The Society may congratulate itself that such a work should have been published under its auspices, and we may in turn congratulate Mr. Macvicar on his work, and on the reception it has met with in scientific circles.

I must now make reference to those of our number who have passed away during the year.

Herr MAX LEICHTLIN.—The first of these is a name well known to all botanists and florists. I refer to Herr Max Leichtlin of Baden-Baden, a Foreign Honorary Fellow and a Corresponding Member of the Society since January 1886, who died on 3rd September last at the advanced age of seventy-nine years. Born at Carlsruhe in 1831, he appears to have had his first horticultural experiences at Ghent, in the famous nursery of Louis Van Houtte. Later he spent some time in the gardens at Glasnevin, Dublin, under the late Dr. Moore; but, naturally enough, he returned to his native country, and devoted himself to growing and collecting plants. His name is surely well known by the specific adjective “Leichtlinii,” which appears added to many species and varieties. His interests seem to have been chiefly centred in plants of the Liliaceous tribe and their allies. I have before me a list of some thirty-five plants introduced by him, and recorded in the “Botanical Magazine” between the years 1870 and 1908, almost entirely Liliaceous, though including other valuable hardy plants such as the beautiful *Incarrillea Delavayi*, *Campanula mirabilis*, and others. There is the fine aubreteæ which

bears his name, the *Primula rosea Ostrouskia magnifica*, and many other choice hardy plants. And yet, though he did so much, his garden was very small—on a steep hillside at his villa at Baden-Baden, laid out in a series of terraces. The climate there favoured him—warmer in spring and summer, and colder in winter than the English climate, and therefore favourable to the cultivation of the plants he was most devoted to. He seems to have been a man of genial and kindly habits, and to have had a host of friends and admirers. He worked among his plants more for love than for money, and never seems to have taken advantage of the commercial side of horticulture which his opportunities and abilities made available to him. His name will long be remembered in botanical circles.

Dr. MELCHIOR TREUB.—The other Hon. Foreign Fellow whose decease I have to record is Dr. Melchior Treub, who died at the comparatively early age of 58, at Saint Raphael, Var, France, on 3rd October last. He, too, had been a corresponding member of the Society since January 1886. He was Professor in the School of Agriculture and Director of the Botanic Garden at Buitenzorg, Java. Dr. Treub was a very great botanist. Born in Holland, he went early to Java, being the first to hold the appointments I have just mentioned. He found there a wide sphere of research, and the result of the earliest of his investigations was the discovery of what is known as Chalazogamy in the fertilisation of certain plants—notably in *Casuarina*. This received great attention from European botanists, and led to much valuable research and discovery in the more temperate regions of Europe. Dr. Treub was of the opinion that his European compeers had their investigations in far too narrow a compass, as tropical vegetation was practically outwith their ken, and he achieved a most important work in establishing in Java a Laboratory to enable European botanists to have a wider field of study, and I believe that this had been taken advantage of by a large number with most valuable results. Dr. Treub has passed away very soon after retiring from his active work, and it is to be feared that his long residence in the Tropics may have hastened his early death.

Turning now to the Resident Fellows no longer with us:—

LORD M'LAREN.—The first name on the list of Resident Fellows whom I would mention is that of a prominent townsman of our own. I refer to the late Hon. Lord M'Laren, one of the Senators of the College of Justice, and a Fellow of this Society since June 1850. With, I think, only two exceptions, Lord M'Laren was the oldest of the Fellows of the Society. He passed away at an advanced age in April last, having been one of our members for sixty years. It seems hardly necessary here that I should refer in detail to the life of one so well known in the City of Edinburgh, with which he had such a close personal connection, and where he was so highly honoured and respected. His interest in botanical science was only one of other avocations with which his somewhat limited leisure time was occupied. Other scientific subjects and other scientific societies equally had their attraction for him, and his high position involved him in much public work apart altogether from the calls of his extensive practice at the Scottish Bar, and, later, his arduous duties as one of the Senators of the College of Justice.

MR. JOHN MONTGOMERIE BELL.—I would record the death of Mr. John Montgomerie Bell, Writer to the Signet, Edinburgh, one of the oldest Fellows of the Society, having become a Resident Fellow in February 1857. The son of the late Alexander Montgomerie Bell, Professor of Conveyancing in the University of Edinburgh, he was born in 1837, and educated at the Edinburgh Academy. He attended the late Professor Balfour's Class of Botany at the University of Edinburgh in 1857, and it is evidence of his enthusiasm as a botanist that he won the class medal for the best herbarium. It is of interest to remember that in August of the following year, 1858, he formed one of a party—I think he was the last survivor of a party—of botanists who, under Professor Balfour, visited Switzerland on a botanical expedition, of which a most interesting record has been published. Travelling was not so quick in those days, and perhaps time was not so valuable, for a week was passed before Switzerland was reached; but, once

there, a fortnight was spent in various centres, and a large and varied collection of Alpine and Continental species was obtained, of which a complete record is in the publication referred to. Besides being a Fellow of the Society, Mr. Bell was a member of the Scottish Alpine Botanical Club and of the Edinburgh Botanical Society Club. Throughout his life Mr. Bell took a keen interest in field botany. In 1898, I think, he accompanied Mr. Alexander Cowan of Valleyfield on a botanical expedition to Norway, extending over some weeks, and at a later date he read a paper to the Society which is published in our "Transactions." Mr. Bell died in June last in his 74th year.

Mr. ALEXANDER MILNE.—I have also to record the death of Mr. Alexander Milne of Messrs. Dicksons, Edinburgh, a Fellow of the Society since March 1883. He was a well-known citizen of Edinburgh, and a member of a very old-established firm of nurserymen. His energies and interests were chiefly directed to Coniferous and Forest trees, but very naturally a business such as his embraced every branch of his profession.

Mr. D. F. MACKENZIE.—Another loss sustained by the Society is in the death of Mr. D. F. Mackenzie, Factor on the estates of Mortonhall, Midlothian, a Fellow of the Society since 1902. Few men in his walk in life were better known than Mr. Mackenzie. His interests were, I must say, chiefly in the department of forestry, on which he was an admitted authority. He had been a member of the Royal Arboricultural Society since 1872, and their Transactions contain many articles contributed by him during the long period of his membership. He was ahead of others in his views as to the necessity for the afforestation or the re-afforestation of waste lands—now so prominently before the people of this country. In 1890 (twenty years ago) he delivered an important address on the subject. He held the position of examiner in forestry to the Highland and Agricultural Society. An important work, and one of distinct interest to the Fellows of the Botanical Society, was carried out in 1893, when Mr. Mackenzie prepared and presented to the Arboricultural Society a

series of micro-sections of a large number of British-grown trees and shrubs, made up into lantern slides, and showing the varying tissues of the different species in an admirable manner. Later on, he prepared and also presented to the Arboricultural Society a very fine collection of micro-photographic slides, illustrative of plant physiology and specially relating to forest trees. In recognition of the original work represented by the preparation of these sections and slides, the Society awarded him their gold medal. Mr. Mackenzie had been in failing health for a number of years before his death in July last, but he stuck to his work and to his duties, and in the end he died in harness, having been taken suddenly ill while in the superintendence of farm improvements under his charge.

Mr. GEORGE STABLES, of Levens Milnethorpe, Westmoreland, a Non-Resident Fellow since November 1883, who died on 4th January last, was a botanist of no mean repute. Born in 1839, he was a schoolfellow of Richard Spruce, from whom he acquired his love for the Hepaticæ; and Mr. Stables is one of the authorities quoted from time to time by Mr. Macvicar in the work recently published. The Cryptogamic Flora of the Lake District was his favourite study, and he has published a valuable series of papers on the Hepaticæ and Mosses of Westmoreland, and has added rare species to the British Flora. One genus, *Stablesia*, has been named after him. Failing sight, however, forced him to retire not only from his profession, but from his favourite study of the Cryptogamia. He had been quite blind for the last year or two of his life, but, notwithstanding this affliction, it was a continual pleasure to him to have plants brought to him that from feeling and description he might identify them. His death occurred very suddenly while sitting in conversation with friends. An appreciative notice of his work is recorded in the "Journal of Botany."

Mr. ROBERT PANTHING was an Associate of the Society since 1898, and an eminent botanist. To the authorities at Kew I am indebted for particulars of his life and work.

Mr. Robert Panthing, whose death took place on 6th February 1910, was a native of the North of England.

His father was in the service of his Grace the Duke of Northumberland, and young Panthling, having early shown an interest in flowers, entered the Duke's service in his sixteenth year as an apprentice gardener at Syon House. After three years' preliminary training there, he was admitted to the Royal Botanic Gardens, Kew, at the age of nineteen, on 5th July 1875. He received promotion at Kew on 7th February 1876, and left on 14th July 1877 to take up a post in the Royal Gardens at Windsor.

His services at Kew had been such that when, in December 1878, a vacancy was announced in the staff of the Government Cinchona Plantations in Bengal Mr. Panthling was recommended as a suitable candidate, and was given the appointment of Assistant in the Cinchona Department in 1879. He had hardly been a year in India when the post of Curator in the Royal Botanic Garden, Calcutta, fell vacant, and he was selected to fill this position. Another year had hardly passed, however, before the post of Senior Assistant in the Cinchona Department also fell vacant, and Mr. Panthling, whose health had showed signs of impairment at Calcutta, was transferred once more to the Cinchona Plantation. Here the rest of his Indian service was spent, eventually being promoted to the position of Deputy Superintendent.

During the whole of the time he had served in the Cinchona department Mr. Panthling had devoted much of his leisure to botanical studies, and more especially to work on the natural family Orchidaceae, of the Indian species of which, and especially the species from North-Eastern India, he had acquired a very extensive knowledge, which he increased not only by study of the living plants he brought together, but by making botanical journeys in Independent Sikkim and in Assam. A natural gift for drawing he cultivated with what excellent results may be judged from the illustrations prepared by him from living plants for the eighth volume of the "Annals of the Royal Botanic Garden, Calcutta," which is devoted to a monograph of the Orchids of the Sikkim Himalayas, of which Sir George King supplied the letterpress while Mr. Panthling supplied the drawings. The talent, industry, and skill to which these illustrations testify were worthily recognised

by this Society when, in 1898, it enrolled Mr. Panthing among its Associates.

The preparation of the numerous drawings included in this work, and of many others of species from provinces other than Sikkim, led to some impairment of Mr. Panthing's eyesight. This circumstance, coupled with the diminished leisure due to his promotion to the executive charge of the Cinchona Plantation, prevented him from making available to the public after 1898 the extensive knowledge of the family which he had acquired, and debarred him to a large extent from further pursuing his botanical studies. His health gave way towards the end of 1909, and early in 1910 he had to be invalided to Europe. He died at Suez, on the way home, after having served the Government of Bengal for thirty-one years, at the age of fifty-four.

That, Ladies and Gentlemen, completes our somewhat melancholy survey of those members whom we have lost during the year. Their record of work and devotion to duty will, I hope, encourage those who are with us, especially the younger ones, to increased zeal and to thoroughness, to much original research, and, let us hope, to the continued efficient and successful carrying on of the great work of the advancement of botanical knowledge and botanical science.

It only remains for me now to repeat my great appreciation of the high honour that the Society has done me in permitting me to hold this Chair for two successive sessions, and to thank all the members of the Society for the consideration and kindness with which they have received my imperfect efforts to carry out its duties. It is with unfeigned pleasure that I congratulate the Society in having selected as my successor Dr. Borthwick, in whose favour I now vacate this Chair.

ON THE PEOPLING BY PLANTS OF THE SUBALPINE RIVER-BED OF THE RAKAIA (SOUTHERN ALPS OF NEW ZEALAND). By L. COCKAYNE, Ph.D., F.L.S. (Plates IX., X., and XI.)

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I. GENERAL.

The relation between the evolution of a land-form and its plant-covering is a matter of high phyto-geographical interest, but one extremely difficult to estimate in the majority of cases, although it seems evident that such a relation must exist. The difficulty arises from the fact that, while geological changes are extremely slow, those of vegetation are comparatively rapid. These latter, too, depend not merely on the topography, but also on climate, on the plants themselves, and on those changes which occur so frequently in the soil, independently of any surface-change. There are cases, however, where the evolution of a land-form may be so rapid as to be watched, as also its synchronous occupation by plants, while the plant-formations themselves may be so distinct, each for its own particular land-form, as to be easily noticeable. The best known case of this kind is afforded by the land-forms and the plant-associations of a dune-area.¹

¹ For a description of those of New Zealand see Cockayne, L., *Report on the Sand Dunes of New Zealand*, Wellington, 1909.

A New Zealand stony river-bed, such as is about to be described, also affords an excellent, though less known, subject for study, while in its case there is probably proceeding before our eyes the same procession of events which culminated in the present steppe-vegetation of the stony river-formed lowland plains and flat valley floors of the higher land. That is to say, the peopling of a sub-alpine river-bed in the neighbourhood of the glacier-source of the stream may be a very similar phenomenon to what happened on the Canterbury Plains during their formation in the New Zealand glacial period. This statement does not imply that the species were then exactly the same as now,¹ but it assumes that similar growth-forms were then existent, and that these would behave as at the present time.

The study has, moreover, an economic bearing, since, leaving the lowland plains out of the question, it deals with the evolution of the vegetation of those "river-flats" which form some of the most valuable grazing-ground of the sheep-farmer, and it is clear how a knowledge of the methods by which Nature clothed them with nutritious grasses has a close bearing on any scheme dealing with their regeneration and improvement.

The subalpine river-bed of the Rakaia has been selected for description, not only because it is typical of the glacier river-beds on the eastern side of the Southern Alps, but because I had an opportunity during the summer of 1909-10 of examining its vegetation in the light of observations made previously elsewhere. The portion studied was the southern side of the river almost opposite the terminal face of the Ramsey Glacier at about an altitude of 900 m. above sea-level, and where the valley is about 1 km. in width. The general aspect of the locality may be better judged from the fine photograph taken by my friend Mr. R. Speight, M.Sc., F.G.S., to whom I am much indebted for many valuable suggestions while preparing this paper, than from any pen description (see Plate IX.).

¹ *Raoulia Haastii* is essentially a plant of forest-climate, and as the neighbourhood of the terminal faces of the great pleistocene glaciers would have, most likely, an extreme steppe-climate, the more xerophytic *Raoulia* species would be the pioneer plants.

2. PHYSIOGRAPHY.

Amongst the many land-forms of the Southern Alps and their environs none are more characteristic than the broad beds of bluish-grey stones, sometimes 1·5 km. or more in width, over which, in many anastomosing streams, the rivers wander.

In the lower part of its course such a river-bed is confined between high, permanent terraces clad with yellow tussock-grasses, but nearer the source the terraces are low and temporary, or altogether wanting, the river's spread being limited only by the mountain slopes on either side. Thus, in many places, the mountain valleys consist of river-bed alone, the origin of which is not difficult to determine.

The Southern Alps are built up for the most part of much-jointed sandstones, greywackes and slates, rocks which are very easily disintegrated by frost. Everywhere the snow-clad mountains are scarred by black patches of rock and present steep precipitous or craggy faces from which avalanches of stones, large and small, fall on to the glacier below in such quantities that the clear ice buried beneath a thick and heaped-up stony covering is frequently not visible for a distance of several miles from the terminal face. Eventually the morainic matter falling from the terminal face of the glacier is seized by the turbulent stream issuing from its ice cave and deposited on the valley-floor, the water exercising a powerful sorting action, so that the stones of the river-bed gradually decrease in size on proceeding towards the sea, huge blocks first of all dominating the scene (see Plate X.).

Besides the actual morainic material the tributary torrents and lateral rivers supply vast quantities of debris, the mountains below the snow-line having in their gullies, and even on their slopes, extensive stone-fields ("shingle-slips") very many metres in length, which afford an inexhaustible supply of material.

The valleys themselves are plainly of glacial origin. The presence of numerous ancient moraines, truncated or ice-overridden spurs, roches moutonnées and other glacial land-forms, testify unmistakably to a former most extensive glaciation, and show that the present ice is but a remnant

of what formerly existed. Furthermore, the upper valleys are of the characteristic U shape, but are now filled to a great depth with shingle, the lofty mountains rising abruptly at a steep angle on either side.

The surface of a river-bed, this being really a narrow stony plain, to the eye looks quite flat, as indeed it is in cross-section, though the gradient is more or less steep, the steepness increasing rapidly as the source of the river is neared. Issuing from its ice cave, the river is generally at first in one stream, the steep gradient and great size of the rocks preventing its wandering, but lower down the bed it soon divides, and at times there may be a dozen or more shallow but rapid streams, bounded perhaps by rudimentary terraces, the number of streams depending altogether upon the water-supply. The streams themselves do not occupy permanent channels by any means: on the contrary, there is a constant but generally slow change in progress, though in time of flood movement can be so rapid that high and dry shingle occupied by vegetation may be swept away, a stream or a naked stony surface subject to more or less frequent submersion occupying its place. On the other hand, a former stream-channel and the ground adjacent may, in their turn, be brought beyond the influence of the rapidly-flowing water, for a longer or shorter period, and become at once suitable for plant life.

As already mentioned, in these upper river-valleys permanent high terraces are wanting, those which occur being merely temporary and quite low structures, the superabundance of material carried by the streams altogether overcoming their erosive power, so that *they build but do not erode*. The river-bed itself is virtually flat, but the surface is far from even. Large stones, or even rocks, stand up above the general level: there are dry watercourses, long since abandoned by their streams, and others only temporarily dry. Islands, small or large, remnants of an older flood-plain, of irregular form with flat surfaces, bearing perhaps a scanty plant-covering, surrounded by water during the heaviest floods, show here and there upon the open river-bed. Close to the slopes, on either side, but never forming a continuous margin, there are frequently other pieces of the old flood-plain, "river flats" they are

called locally, occupied by vegetation, even, perhaps, by a closed covering, and quite abandoned by the river proper, though at their junction with the present flood-plain they end in a ragged or undermined face of bare stones.

The streams are not confined to any special part of the bed, but generally every few kilometres the main stream crosses from one side to the other of the valley, the point of departure being very often a rocky bluff against which it abuts, there deepening its bed and depositing its load of shingle on the lower side of the bluff. Thus the river-flat, lying below such a rocky point washed by a non-shifting main stream, is the most stable portion of the valley, and bears the oldest plant-covering.

The Rakaia river-bed here dealt with shows excellently all the features detailed above. The two glaciers from which the source-branches of the river issue are covered with an astonishing quantity of moraine (see Plates IX. and X.) for a distance of several kilometres from their terminal faces; there are numerous torrents bringing shingle from the *débris*-fields, and distributing it, fan-like, on the main river-bed; there is a wide expanse of bare shingle traversed by a network of unfixed anastomosing streams subject to frequent floods; there is abundance of dry stony ground, and there are islands and flats of every degree of stability. The stable flats are themselves watered by streams, which may be connected with the main river or have their origin on the adjacent heights, but these streams are generally much less rapid than the branches on the flood-plain proper, and may contain more or less plant-life in consequence. The main stream at about 4 km. from its source in the Lyall glacier flows all in one channel (see Plate IX.) except at flood-time, and generally rushes with such violence that the sound of the great stones it carries along, grinding one against the other, may be heard very plainly even from the slopes 600 m. above, or more.

The river-water contains a very great amount of fine glacial mud, so that it is quite milk-white in colour, consequently the retreating waters after a flood leave much fine silt deposited between the stones, or coating the floors of hollows with a layer of varying thickness.

It is evident that a river-bed such as is here described offers a quite unstable substratum for a plant-covering; but, generally speaking, the changes wrought by the shifting streams take place slowly, and there is a gradual procession of events from the merely temporary occupation by plants of ground liable to frequent submersion to closed associations of considerable age. These latter, where a river flows through a narrow valley with mountains descending steeply on both sides to the flat bed, are always liable to destruction, but nevertheless extensive stony flats, situated at no great distance apart, and occupied by grass, shrub, or even forest formations, are quite common and bear the appearance of perfect stability and considerable age. Notwithstanding the extreme instability of river-bed vegetation, a complete cycle of events is always in view, every progressive phase of the development of the vegetation existing at various spots from the first insecure occupation of the ground to its final conquest by steppe, shrubbery, or forest.

3. ECOLOGICAL CONDITIONS.

(a) CLIMATIC.

Although no statistics are available as to the rainfall and number of rainy days at the source of the river Rakaia, there can be no doubt that both are excessive, the former, judging from statistics elsewhere, doubtless exceeding 250 cm. a year. There is, in fact, a *forest-climate*, which is defined by the average distance reached by the heavy rainfall from the west, as distinguished from the dryer, or *steppe-climate*, of the area lying to the east of this line. Heavy downpours, accompanied by high wind, constantly occur on the mountains and in the valleys near the sources of the glacial rivers, while at a kilometre or two to the east there is no rain at all, but a fierce gale favouring excessive transpiration will rage.

Snow must fall in great abundance at the higher levels during the months of June, July, and August, and, indeed, heavy falls occur both earlier and later than those months. But at the altitude of the river-bed here dealt with it is probable that snow does not usually lie upon the ground

for more than a week or two at a time: in other words, the river-bed lies at some distance below the winter snow-line.

As for the heat factor, the average temperature is doubtless less than in the lowlands, nor will there be nearly as much sunshine as even at the same altitude, or higher, further to the east. But on clear days insolation is very powerful, as evidenced by the heat of the stones of the river-bed. Judging from other parts of alpine New Zealand, the minimum temperature probably does not exceed -18° C. But it must be pointed out that frost may occur during any month of the year: that in the shade the ground may remain hard-frozen for several days at a time, and that even in winter the plants will frequently lack the protection, not only from cold, but from the excessive transpiration that a snow-covering affords.

The wind blows with extreme violence from the north west, the prevailing quarter. Its effect on increasing transpiration is frequently much lessened through its being charged with moisture and its not being a dry wind, as further to the east. On the river-bed the violence of the wind is intensified, hemmed in, as the valley is, by the contiguous high mountains.

From the above it may be seen that the climate is partly hygrophytic and partly xerophytic, for the effect of the excessive rain is neutralised by the insolation, the frost, and, above all, the high winds, so that although there are periods when typical hygrophytes could thrive, there are also frequent periods which demand xerophytic structure.

(b) EDAPHIC.

The soil conditions of a river-bed are in a perpetual state of change. This arises from three causes: the first of which is the humus-making power of special growth-forms, especially of certain cushion-plants which rapidly convert their old leaves and shoots into soil: the second, the catching power of the plants with regard to wind-borne dry glacial silt (rock-flour); and the third, an ever-varying distance of roots from ice-cold water.

Leaving the humus out of the question for the present, the soil consists chiefly of stones, large and small, mixed

On the under side of almost any leaf of any of our common trees there are to be found tufts of hairs, often at the angle where a side vein joins the midrib. The small hollows behind the hairs are the homes and shelters of the mites, and have been called acarodomatia. Within the little angle where the side vein branches off, there is often a curiously intricate and complex little cavern reaching up into the tissue, and guarded by a sort of *chateau-de-frise* of special trichomes.

I have tried to draw sections of these little caves, but gave up the attempt in despair, for they are very difficult to section and are almost impossible to draw.

During the day, the mites pass their time in these caverns. If disturbed, they come out with every appearance of irritation and run about with extraordinary quickness, or, as Lundstrom says, with "unglaublicher Schnelligkeit." They are strictly nocturnal, like so many other beasts of prey, and object to being exhibited in daylight.

As the summer goes on, they seem to get more and more numerous, and they are especially abundant in September; but when the leaves begin to dry up, and the little hairs which guard the entrances of their shelters shrivel away, some of the mites abandon the leaves altogether and appear to take refuge in crannies of the bark, in the bud-scales, often in the fruit, and sometimes even on the seed itself.

It has been found that, when such seeds are sown, the mites infect the seedling leaves as soon as these are sufficiently mature.

I am by no means sure that all the mites abandon the leaves before the latter fall in autumn. I suspect that many winter in leaf-mould, but only a skilled entomologist could decide such questions. On the bramble in spring I have found mites still active on last year's leaves when the new leaves were just ready to be infected. I have also found them in the lenticels of an oak and on the cut end of a pear twig.¹

It is clear, however, that there is no difficulty about the succession of mites from year to year.

In the summer the number of these mites is extra-

¹ These may not have been the mites which inhabit the leaves in summer.

ordinary. It is difficult to realise this point until one has really tried to find them systematically.

I have myself observed them on the following plants, though not always in special acarodomatia. If there are appropriate nooks or crannies somewhere on the plant which are fit for shelters, the mites naturally make use of them. I ought to mention also that these were all the benignant mites, not, so far as I could judge, the sucking "red spiders":—

Anemone japonica, peony, larkspur, aconite, a garden form of *Thalictrum minus*, *Helleborus viridis*, *Liriodendron tulipiferum*, common barberry, mahonia, *Hypericum androsaemum*, *H. calycinum*, *Gypsophila* sp., *Lychnis chalcidonica*, *Sidalcea malvaeflora*, common lime tree, ivy-leaved geranium, *Acer rubrum*, common sycamore, *A. campestre*, horse-chestnut, holly, *Dictamnus fragrantella*. They are very common both on Leguminosae and Rosaceae. I found the following plants to be regularly inhabited, viz.:—Broom, *Vicia cracca*, bean, kidney bean, *Lupinus mutabilis*, *Galega orientalis*, *Robinia pseudacacia*, common laburnum, gooseberry, black currant (*Phytopyrus* is not common at Newton), bramble, raspberry, loganberry, strawberry, common sloe, gean, cherry, *Prunus padus*, *P. laurocerasus*, *P. lusitanicus*, *Spiraea ulmaria*, *S. filipendula*, *S. aruncus*, and three other species of *Spiraea*, *Geum urbanum*, *Rosa canina*, *Cotoneaster frigidus*, hawthorn, apple, pear, *Pyrus aucuparia*, *P. fennica*, *Epilobium montanum*, *Deutzia crenata*, *Philadelphus* sp., and *Astilbe* sp., *Heracleum spandgliaum*, *Eryngium planifolium*, ivy, *Aucuba japonica*, common elder, *Viburnum opulus*, honeysuckle, *Valeriana pyrenaica*, *Cephalaria tartarica*, *Echinops Ritro*, *Senecio vulgaris*, *Solidago virgaurea*, Jerusalem artichoke, tansy, *Aster corymbosus*, Michaelmas daisy, and a tall garden variety of *Achillea millefolium*, *Campanula carpatica*, *Lobelia cardinalis*, *Rhododendron ponticum*, common azalea, *Lysimachia vulgaris*, *Fraxinus latior*, *F. ornus*, lilac, privet, *Forsythia viridissima*, *Gentiana asclepiadea*, *Veronica longifolia* var., *Antirrhinum majus*, foxglove, *Lamium maculatum*, *Monarda didyma*, *Polygonum virginicum*, box, common nettle, *Ulmus montanus*, alder, hazel, birch, oak, beech,

hornbeam, *Salix caprea*, Solomon's seal. They also occur on the male fern, lady fern, and common bracken—that is, on about 113 species, mostly of herbaceous garden plants, and belonging to 44 natural orders. These were observed in the garden at Newton, near Dumfries (Kirkcudbrightshire), and at various places in Dumfriesshire.

This list is by no means the result of an exhaustive study of common British plants. I began by choosing plants at random, intending to obtain a percentage of British and cultivated forms which are regularly visited. But I have been so often deceived by not at first detecting the mites that I came to the conclusion that such a list would be misleading.

It is very difficult to be sure that any plant is free from them. No one would ever suppose that almost glaucous rain-shy plants like *Gypsophila* and *Thalictrum* were inhabited by them. Nor are they absent from either glossy leaves or very hairy leaves, as some have supposed.

It has been said by several authorities that acarodomatia only occur on dicotyledonous trees and shrubs. That is not, however, the case. They are very common on tall herbaceous plants, and even occur on quite lowly herbs, though this is unusual.

True acarodomatia have been found on two species of *Dioscorea* in the Congo by de Wildemann (2), and Zimmermann (3) also speaks of mites on the under side of the leaves of *Arundinaria japonica*. That they occur on the common Solomon's seal, where I found them abundantly at the base of the stem leaves, is a very interesting point.

Another point that should perhaps be mentioned is that acarodomatia do not afford a clear proof of a warm, humid climate. Peola (4), in studying the fossil Tertiary flora of Piedmont, discovered well-marked acarodomatia on the leaves of *Oreodaphne Heerii*, *Cinnamomum polymorphicum*, and *Laurus canariensis*; but it can hardly be said that this in itself shows that the climate was warm and humid. There are plenty of acarodomatia not only in Britain but in the tropics.

It would be easy to give a list of those plants which have acarodomatia, but this is hardly necessary. The researches of Lundstrom, von Lagerheim (5), Malme (6),

Loesener (7), Schumann (8), Ludwig (9), Magoczy-Dietz (10), Penzig and Chabrera (11), Guerin (12), Delpino (13), and Rocchetti (14) have shown that these shelters exist in the following natural orders, viz.: Melastomaceæ, Menispermaceæ, Euphorbiaceæ, Piperaceæ, Dipterocarpeæ, Thymeleæ, Styracaceæ, Simarubeæ, and especially in Lauraceæ and Rubiaceæ. The last-mentioned author has a list of 270 acarophilous species.

Moreover, many plants which are regularly visited or inhabited by mites are without anything that one can call an acarodomatium. The mites take up residence in any convenient nook or cranny, and one cannot say that these crevices are specially produced for the good of the mites.

Thus many forest trees have holes in the trunk where some branch has decayed away, and birds such as the titmouse nest in holes of this kind. Titmice are very useful to the trees, and find these hollows very convenient, but the holes were not formed for the good of the titmouse, although this bird is one of the most useful of British species.

When one reflects on the multitude of mites visiting regularly so many plants, it is impossible not to speculate as to what is their part in the general economy of plant life.

Lundstrom suggested that they kept the leaves free of dangerous fungi and insects.

It is well known that in tropical and subtropical countries many plants are subject to the attacks of leaf-epiphytes. It is quite common to find leaves entirely covered by a heterogeneous vegetation of algæ, lichens, mosses, and liverworts. Stahl has figured the leaf of a *Medinilla* so overgrown by an epiphytic vegetation of this kind that it must have been impossible for it to carry on its functions. Such leaf-epiphytes are exceedingly common in many vegetation formations in the tropics.

Now, most of Lundstrom's mite-plants belong to certain districts in South America. Malme some time afterwards visited the same locality. He found that in these light woods known as "Capoes" smooth-leaved shrubs were infested with these epiphytes, but that the acarophilous plants with acarodomatia were much less or not at all affected. Penzig and Chabrera confirm this observation.

Even in this country it is unusual to find either "red spider" or "Phytoptus" on the same leaf as the benignant mites. I have never myself seen them together, and very seldom seen aphides accompanying the true mites.

Certain observations which have been made on the habits of the benignant mites are of great importance.

Their mouths are not adapted for sucking the sap of plants, but for chewing or biting (Aurivillius (15)). Lundstrom himself saw fungus spores between the mouth parts of living acarids. Spores and fragments of fungus hyphæ have been found in their shelters. Dr. Aurelio de Gasparis caught *Tydeus foliorum* in the act of piercing an insect's egg.

According to Banks (16), *Tydeus glöckeri* eats the eggs and young of scale insects, and both Rhyncholophus and Cheyletus are also said to prey on scale insects. Cheyletus also eats the eggs of a cicada, and certain Gamarid mites live on minute plants, bacteria, small fungi, etc.

These observations seem almost to prove the truth of Lundstrom's suggestion. It would be interesting to try if these mites could not be utilised to keep down "mussel scale" and similar pests in greenhouses.

These mites, therefore, may be regarded as an active and numerous police, keeping in check all sorts of fungus and insect pests which might otherwise do serious harm.

But there is another possibility which, to my mind is of even more importance.

The atmosphere is, in its lower layers, crowded with enormous quantities of motes or dust-particles. They are of the most diverse origin. Of the inorganic dust-particles some did not belong to our earth originally, but formed part of a falling star or perhaps a comet's tail. Other particles have been thrown out in volcanic eruptions. The dust from Krakatoa, for instance, is said to have been reflected out and back again, and to have passed right round the world three or four times.

Fine dust from the Sahara and other deserts probably travels great distances. I have seen quantities of it on a steamer's deck quite a long way from shore. Mr. John Aitken (17), in one of his classical papers on this subject, describes how dust-particles from the densely inhabited

districts of France and Belgium seemed to have been caught up in a cyclone, carried right round by the north of Scotland, and reached his instruments at Kingairloch (28 miles from Ben Nevis) with a north-westerly wind.

These inorganic dust particles must, therefore, be miscellaneous: they probably differ both in chemical constitution and in physical character, though they are all exceedingly minute.

But the organic part of the dust-particles is perhaps even more interesting.

It is hardly necessary to say much about the enormous number of germs, spores, pollen grains, and other organic material which seems usually to hover in the atmosphere.

Dust-like seeds are characteristic of many phanerogams, and especially, according to Ridley, of many of those which have colonised oceanic islands. Fern-spores also must be abundant in the atmosphere. I need hardly recall the classic case of Krakatoa, for, even in this country, many kinds of ferns and even some flowering plants establish themselves on trunks of trees, bridges, and walls, sometimes miles away from their nearest neighbour.

With mosses and lichens, the facts of their distribution both in the Arctic and Antarctic and on mountain summits are very remarkable. Fink (18) discovered no less than thirty forms of lichen on a wall that had only been built thirty years. One should also mention, perhaps, the trades dust which falls in the Atlantic, and which consists of an alga, *Trichodesma Hildebrandtii* forma *atlantica*, the regular distribution of yeast-cells on fruits, Dietel's experiments which showed that spores of rust-fungi could always be detected on plates left exposed during the summer.

Many other instances could be mentioned, but this hardly seems necessary. One of the most recent papers, however, can hardly be omitted in this connection.

Galeotti and Levi (19) studied the distribution of bacteria and fungus spores on the snow of high Alpine summits. From a cubic centimetre of water melted from the snow found on Point Strahling, at an altitude of 3116 metres, they obtained 147 colonies of bacteria and 20 colonies of Hyphomycete fungi. In one case (Lyskamm) they found only one colony of Hyphomycetes: yet on another summit

(4560 metres). Gnifetti, there were no less than 40 bacterial and 3 fungus colonies from a cubic centimetre of melted snow.

However much allowance may be made for the share taken in the transport of spores by insects and birds, these instances are enough to show that even at altitudes of 13,000 feet the air contains living spores in great abundance.

When rain falls, a very large proportion of the floating dust-particles is washed out of the air and falls upon the foliage of plants. When the drops reach the leaves, the water is carried down to the petioles and stems by a series of grooves and gutters or flat surfaces which differ almost in every particular type of leaf.

These ingenious contrivances for carrying off rain-water are much too complicated to describe, but the result is to deposit all dust contained in the rain on certain well-defined lodging-places, usually about the base of the lamina or of the petiole.

I examined this dust microscopically, collecting it from about 26 species of plants. The results were too monotonous for it to seem worth while to go further into this side of the question.

In every case I found such easily recognised objects as lichen soredia, spores of rust-fungi, algal cells, pollen, yeast cells: in every case bacteria were to be seen. The proportion of these organic particles seemed to me extraordinarily high, at least in all cases when the leaf was more than 18 inches above the ground.

The point which most impressed me was the extraordinarily high manurial value of this plant-dust.

Not only does the inorganic part consist of very fine particles of the most varied mineral character, but the organic part not only forms a large proportion of the dust, but consists mainly of spores, etc., which must contain the most concentrated nutritive material.

Not only so, but there are grazing animals, the mites, to devour this combined nitrogenous matter, and, as I have pointed out, bacteria are available to break up and transform the waste products.

If this material, when dissolved in rain-water, enters

the leaves, then it seems that a whole series of complex adaptations have been prepared to utilise all this rich air-food.

But here I am on very delicate and dangerous ground. Is it possible for rain-water with dissolved salts to enter the leaf?

That question has been debated, often with great violence, for something like 170 years. Naturally, I do not wish to dogmatise on this difficult point. But several of the best authorities on vegetable physiology admit that such absorption does take place. Both Sachs and apparently Vines agree that this is possible. Pfeffer remarks as follows: "Dem Gemass können sehr wohl kleine Quantitäten von gelösten Stoffen mit Regen und Thautropfen in die Blätter gelangen." I do not find Kny's (21) experiments in the least conclusive. They have been often quoted as showing that no such absorption takes place, but the following extract seems to me to show that such absorption can take place even under very heroic treatment: "Die in Oel steckenden besprengten Zeigten Beginn des Welken; die in Oel steckenden nicht besprengten waren stark welk." Neither Liebig nor indeed anyone supposes that such absorption can be large in amount. It is probably only a very minute proportion of the water that enters by the roots.

Nevertheless, when one remembers the rich manurial value of this dust, that it is carefully strained out of the rain by a whole series of elaborate contrivances, and also that there are neat arrangements for encouraging mites to reside permanently on the leaves, one can only draw the conclusion that mites, bacteria, and rain-gutters in the leaves form together one of the most interesting cases of symbiosis that has yet been discovered.

AUTHORITIES.

- (1) LUNDSTROM.—Acta Nova Upsal., ser. 3, xiii., 1886-1887; Bot. Centralblatt, 1886, p. 282, and 1890, p. 246.
- (2) DE WILDEMAN.—Com. Rend., 1904, pp. 551 and 913.
- (3) ZIMMERMANN.—Ann. Jard. B. Buitenzorg, xvii., 1900-1.
- (4) PEOLA.—B Soc. Geol. Ital., xxiii., 1904.
- (5) VON LAGERHEIM.—Bot. Centralblatt, 1892, p. 238.
- (6) MALME.—Svenska Vet. Akad. Handl., Bd. xxv., 1900.
- (7) LOESENER.—Biolog. Centralblatt, Bd. xiii., 1893.
- (8) SCHUMANN.—Pringsheim, Jahrbuch, xix., 1888.
- (9) LUDWIG.—Biologie d. Pflanzen, 1888.

- (10) MAGOCZY-DIETZ. —Bot. Centralblatt, xliii., 1891, p. 393.
- (11) PENZIG and CHABRERA.—Malpighia, anno xvii., 1903.
- (12) GUERIN.—B. S. Botan. de la France, tom. liii., 1906.
- (13) DELPINO.—B. S. Bot. Ital., x., 1901.
- (14) ROCCHETTI.—Contrib. Biol. Veg., iv., 1905.
- (15) AURIVILLIUS.—Acta Nova Upsal., ser. 3, xiii., 1886-87.
- (16) BANKS.—Proc. U.S. Nat. Mus., xxviii., 1905.
- (17) AITKEN.—Trans. R.S. Edin., xxxvii., pt. 3, 1894.
- (18) FINK.—Bot. Gazette, xxxviii., 1904.
- (19) GALEOTTI and LEVI.—Arch. Ital. de Biol., tom. liii., 1909.
- (20) PFEFFER.—Pflanz. Physiologie, Leipzig, 1897.
- (21) KNY.—Ber. d.d. Bot. Ges., Bd. iv., 1886.

ON SOME BRITISH HYBRID ROSES. BY J. R. MATTHEWS.
(Plate XII.)

Although within recent years considerable attention has been given to the genus *Rosa*, much still remains to be done in way of systematic classification. This is perhaps more true of the section of *Pimpinellifoliae* hybrids than of any other section of the genus. The difficulty obviously arises from the hybrid origin of these roses: and until their exact parentage is known, it seems to me impossible to expect a satisfactory classification of the individual species which go to form the three groups of the section. Especially is this true of the group *Pimpinellifoliae* × *Villosae*, where too much stress has been laid on technical characters, such as size and serration of leaflets, glandularity, hairiness, etc., and little or no reference has been made to the characters of the possible parents.

The position of the sepals appears to be a very important consideration, but the determination of this point is frequently rendered difficult owing to the fact that in most of these hybrids the fruit aborts before the real position of the sepals can be ascertained. But if this matter could be determined from observation of the *living* plants (herbarium specimens are not always to be depended upon), a great advance would be made in determining the second parent, and, as a consequence, the classification of the species would be rendered easier and, at the same time, more natural.

It is not my intention to give a detailed description of all the hybrid roses that have been found in Britain. That

has already been done in "Journ. Bot." 1910. I propose merely to indicate the three groups which are represented in this country, with occasional reference to the forms which are found in the neighbourhood of Edinburgh, and to give some idea of the work which has already been done on this section of the genus.

On the whole the hybrids are easily recognisable. Their foliage generally, but not always, recalls that of *R. pimpinellifolia* in shape and colour. There is always and often a decidedly marked admixture of acicles on the stem and branches, and the fruit is in most cases very imperfectly developed.

The largest of the three groups is *Pimpinellifolia* × *Villosæ*, collectively called *R. involuta*, Sm. Several varieties have been described, but these seem to run so closely into each other that it is very difficult to distinguish them, however well defined on paper.

R. involuta was first described in 1804 by Smith in "Flora Britannica," but at that time was not recognised as a hybrid. Baker, in his "Monograph of British Roses," 1869, includes *R. involuta* in the group *Spinosissimæ*, with which of course it must have some affinity since *R. pimpinellifolia* is one of the parents. But this is sufficient to show, I think, that Baker was not aware of the hybrid origin of the rose. It was not, in fact, for a number of years after the appearance of the monograph that Dr. Christ¹ promulgated the idea that *R. involuta* is a hybrid of *R. pimpinellifolia* and *R. tomentosa*, a member of the subsection *Villosæ*.

Several years after Smith's earliest description there appeared in "Trans. Linn. Soc." 1818, an account by Woods of a variety of *R. involuta* which its author named *R. sabini*. This differs from the former in having its leaflets fully compound-glandular-serrate, its sepals pinnate, and its prickles more scattered. But since Woods' description appeared, a number of intermediate forms have been figured, and under *R. involuta*, Sm. in the "London Catalogue Ed. 10," we find a list of twelve varieties.

R. sabini, Woods, is considered by Baker to be much more common than *R. involuta*, reaching its maximum frequency

¹ "Botanisches Centralblatt," 1884.

in the north of England: but as *R. incoluta* has the right of priority, that name must stand at the head of the group. The hybrid, however, is not infrequent in Scotland. In the Edinburgh district it occurs at Port Seton and at Ormiston, growing near *R. hibernica*, to be referred to in the sequel. I believe further investigation will prove its occurrence in other localities. With regard to the distribution of the hybrid in Scotland it is interesting to note that Don discovered it "on a rock on one of the mountains at the head of Clova near the limits of perpetual snow." Hence Don named it *R. nivalis*. One specimen of Don's plant, thus named, is in the herbarium of the Edinburgh Royal Botanic Garden, and on the sheet, Prof. Crépin, in his revision of the roses in the herbarium, has written "*involuta*."

In 1892 a very interesting and curious form of this hybrid was discovered by Mr. Barclay near Auchterarder Station, and through his kindness the plant was pointed out to me. Specimens were sent to Prof. Crépin, and regarding it he reports as follows:—"It is truly remarkable that I have seen nothing like it from the Continent or from other localities in the British Isles. Its leaflets are profusely glandular below, and have many glands on the upper surface: but what is extraordinary is that there are numerous long, stiff bristles clothing the pedicels and receptacles. At first sight one would imagine it to be the hybrid *R. pimpinellifolia* $\times$ *rubiginosa* (*R. echinocarpa*, Rip.): but this idea cannot be entertained when we look at the prickles, which are straight or but slightly curved. Moreover, *R. rubiginosa* is not found in the immediate neighbourhood. On the other hand, there is found growing beside the hybrid a form of *R. tomentosa* with leaflets glandular on both surfaces, and with pedicels and sepals thickly hispid-glandular. Let us not forget to add that the axes of this hybrid have quite the armature of the ordinary varieties of *R. sabini*, Woods, that its receptacles have ripened, quite full of achenes, and that its sepals are persistent."¹

Every year this hybrid bears a large crop of well-developed fruit, a point on which Crépin lays considerable

¹ "Notes on Scottish Roses," W. Barclay in "Ann. of Scot. Nat. Hist.," 1896.

emphasis: and this is indeed exceptional, for in the case of most other hybrid roses the fruit is largely abortive. Probably this rose is pollinated from the *tomentosa* form which grows near it.

In order to make certain whether the seed is fertile or not, I have, this autumn, sown a quantity of it. It would be very interesting indeed to know of its germination.

In this group, as in the two following, *R. pimpinellifolia* or its variety *R. spinosissima* is always one parent, but the question arises whether the second parent be *R. tomentosa*, Sm., or *R. mollis*, Sm. The problem is a difficult one, especially with regard to hybrids found in Scotland, where *R. mollis* is at least as plentiful as *R. tomentosa*. In the south of England, as Major Wolley-Dod has pointed out, *R. mollis* cannot be the second parent, for it does not grow there. Thus some clue may be obtained by noticing what species are dominant in the locality where the hybrid occurs. In the meantime the exact parentage seems to be obscure. The one conclusive proof would be to obtain the same forms reproduced from their parents by artificial methods.

Crépin, in his "*Rosae Hybridæ*,"¹ describes a form of *R. involuta* from Sutherland which he considers to be *R. pimpinellifolia* $\times$ *mollis*. One sheet of this hybrid is in the Botanic Garden herbarium, the specimen having been sent by Rev. E. S. Marshall, who, in a note, declares it to be from the original plant described by Crépin. The specimen certainly approaches nearer *R. mollis* than *R. tomentosa* in several of its characters, but in other forms of the hybrid, as, for instance, those found near Carnoustie, it is very difficult to decide which is the second parent.

With regard to the Auchterarder rose, it seems quite certain that the second parent is the glandular form of *R. tomentosa* which grows beside it. In many features the hybrid is nearer *R. tomentosa* than *R. pimpinellifolia*.

The second group, *Pimpinellifoliae* $\times$ *Eu-caninae* is a small one, and collectively is called *R. hibernica*. The main prickles are stouter and more hooked than in the first group, often quite curved as in *canina* forms. The foliage recalls that of *R. pimpinellifolia*. The leaflets are small.

¹ "Bulletin de la Soc. Roy. de Bot. de Belgique," 1894.

mostly uniserrate, quite eglandular beneath, and usually, but not always, glabrous. The amount of pubescence seems to depend on which variety of the *eu-canina* is the second parent.

Until recently Smith's description in "Eng. Bot.," 1810, was accepted as the earliest, but it has been pointed out in "Journ. Bot.," 1907, that the same rose had been described by Templeton in "Trans. Dublin Soc.," 1802, and so he must stand as the author of the name. At all events, Dr. Christ was again the first to express the opinion ("Journ. Bot.," 1875) that *R. hibernica* is a hybrid of *R. pimpinellifolia* and a *canina* form.

In 1866 the plant was collected by Gorrie near Ormiston, and this is probably the first record for Scotland. In "Trans. Bot. Soc.," 1867, we read: "Mr. Gorrie presented specimens of a rose which he found growing on the side of the old road which divides the counties of East and Mid-Lothian, between Melville Hall and Bellyfurd Burn, in the month of August last." Gorrie sent specimens to several botanists, but no one referred it, at the time, to any named species. It seems that Sadler, some years afterwards, had sent specimens from the same bush to Baker, who referred it to his variety *laccigata* of *R. involuta*. This simply points to the difficulty of referring these hybrids even to their proper group. On the sheet of Gorrie's plant in the Botanic Garden herbarium there is the following note by Webb:—"In 1876 I happened to be alongside Baker at Kew when he was sorting some specimens for the herbarium. Among them was a rose from Sadler to be named (a previous insufficient specimen had been sent, but not complete enough to determine), and I believe these specimens are the same. Baker called it *R. involuta* var. *laccigata* of his monograph. From the present specimens I have little hesitation in saying *hibernica*." It would appear, therefore, that Webb was the first to refer this Ormiston rose to its proper place.

The plant resembles the original Irish forms in having the under surface of the leaflets hairy, and, until two years ago, was the only form of *R. hibernica* with hairy leaflets known in Scotland. In "Ann. Scot. Nat. Hist.," 1908, it is recorded from Banffshire by Mr. Barclay. The leaflets of

the Banffshire rose are less hairy than the Ormiston and Irish forms, and the fruits are abortive to such an extent that Mr. Barclay finds it difficult to decide whether the sepals become erect or not. There is, consequently, considerable difficulty in determining whether the second parent is *R. dumetorum*, Thuill., or *R. coriifolia*, Fr.

Being anxious to see the Ormiston plant, I visited the locality this autumn, and, guided by directions from Mr. Barclay, I had no difficulty in finding the bush. Unfortunately it had not flowered owing to a recent and evidently severe trimming. All I was able to obtain were portions of strong vegetative shoots which had grown most vigorously.

In "Review of British Roses," Baker describes a marked variety of *R. hibernica* which he calls var. *glabra*. He reports it from Sutherlandshire besides several English counties: but as no date is given for the Scottish record, it is difficult to say whether this or Gorrie's plant was the first *hibernica* for Scotland. In var. *glabra* the leaflets are glabrous, and this indicates that the second parent is one of the glabrous varieties of the *ca-canina*, probably *R. canina*, L., or perhaps *R. glauca*, Vill. The variety *glabra* has been recorded from at least three other Scottish counties—Banff, Aberdeen, and Perth, but in the last it is now extinct. In both the north of Scotland localities the sepals are reflexed, and this gives rise to the idea that the second parent must be *R. canina*, possibly of the group *lutetiana*, Léman. Yet *R. canina* is less frequent in the district than *R. glauca*, and one would have expected, as Mr. Barclay has pointed out, *R. glauca* to be the second parent. But *R. glauca* has the sepals erect.

Dr. Christ's opinion was that the Irish forms of *R. hibernica* had for their second parent a form of *R. canina* which has reflexed sepals. Crépin, in his "Rosae Hybridæ," holds a different view, and believes that the second parent is *R. coriifolia*, which has erect sepals. In support of this view he refers to a specimen in Botanic Garden herbarium in which the sepals are quite erect. But others, as we have seen, have the sepals reflexed.

To summarise, it seems to me that forms of *R. hibernica* with erect sepals are likely to have for the second parent

R. coriifolia or *R. glauca*, the former if the leaflets are hairy, the latter if the leaflets are glabrous. If the sepals become reflexed either *R. canina* or *R. dumetorum* may be the second parent, the former if the hybrid has the leaflets glabrous, the latter if the leaflets are hairy.

A new variety of *R. hibernica* has been described by Mr. Barclay in "Journ. Bot.," 1910, p. 332; and since I was with Mr. Barclay when the plant was found, it may not be out of place to mention the record here. The locality is the sea coast about one and a half miles east of Port Seton.

In all the described British forms of *R. hibernica*, the serration of the leaflets is simple or very nearly so, and the sepals and peduncles eglandular. The Port Seton plant differs in having leaflets with a decidedly compound serration, generally two but sometimes three denticles on the lower edge of each tooth and occasionally one on the upper, the majority of the denticles ending in a gland. The leaflets, like some other forms of the hybrid, are hairy on the under surface. The peduncles are sparingly glandular, sometimes naked. The sepals are nearly simple, and more or less glandular on the back.

According to Mr. Barclay, no form resembling this has been previously found either in Britain or on the Continent. *R. armatissima*, Déség., a form which occurs on the Continent, is described as having biserrate leaflets, but without hairs on the under surface, and quite eglandular. Thus the second parent in the two forms cannot be the same.

The second parent of the Port Seton rose, since the sepals become erect and since the leaflets are hairy, is probably a variety of *R. coriifolia*, Fr., with biserrate leaflets, and with peduncles and sepals glandular, *i.e.* a variety of the group *R. Watsoni*, Baker.

The third group is *Pimpinellifoliæ* × *rubiginosæ*, and so far as I know, the hybrid has not in this country received a specific name. The rose is rather rare, and it is only within recent years that its occurrence in Britain has been hinted at, although a form resembling it has been known on the Continent for some time. It occurs in only a few places in Britain. It has been found in the south of England, and till this year was known in two localities in Scotland. Mr. Barclay discovered it near Caputh in 1897, and a few years

later it was noticed by Prof. Trail near Turriff. It was afterwards discovered, however, that the rose was actually being cultivated in that district, the cultivators believing that they had in their gardens the true sweet-briar. It seems probable, then, that Prof. Trail's plant is an escape from cultivation. Or the reverse may be true. The plant may be a natural hybrid which has been taken into cultivation from nature. Against this view is the fact that neither *R. rubiginosa* nor *R. pimpinellifolia* was observed in the district. The Caputh bush, Mr. Barclay says, is undoubtedly a natural hybrid, for there it is growing beside its parents.

Another locality is now known where the rose grows plentifully. I refer to that part of the Haddington coast between Port Seton and Longniddry, where it was found in September last by Mr. Barclay, its occurrence being noted in "Journ. Bot.," 1910, p. 260. On October 1st, in company with its discoverer, I had the pleasure of seeing the growing plant, and of collecting specimens. It grows in large clumps, and some of the bushes are luxuriant, attaining a height of eight or nine feet. A fair quantity of fruit had ripened, though a greater quantity had aborted. On examining several receptacles, however, I found that only a few achenes had developed.

The hybrid resembles *R. rubiginosa* in possessing sub-foliar scented glands, and also in having these glands distinctly stalked. The prickles are numerous and unequal, the smallest straight, the others compressed, dilated, and curiously uncinate. Two distinct forms were found as regards the fruit. One form possesses long fruit, whereas the other has it globose. The former variety is quite new to Britain. In other features the two forms are similar.

There can exist no doubt whatever that the rose at Port Seton is a natural hybrid. No better chance for hybridisation could be imagined, for both parents are growing in close proximity. In some places it was noticed that their branches were interlacing. It is more than likely that other hybrid forms are to be found in the same locality, and I am quite certain that a careful search would be well rewarded.

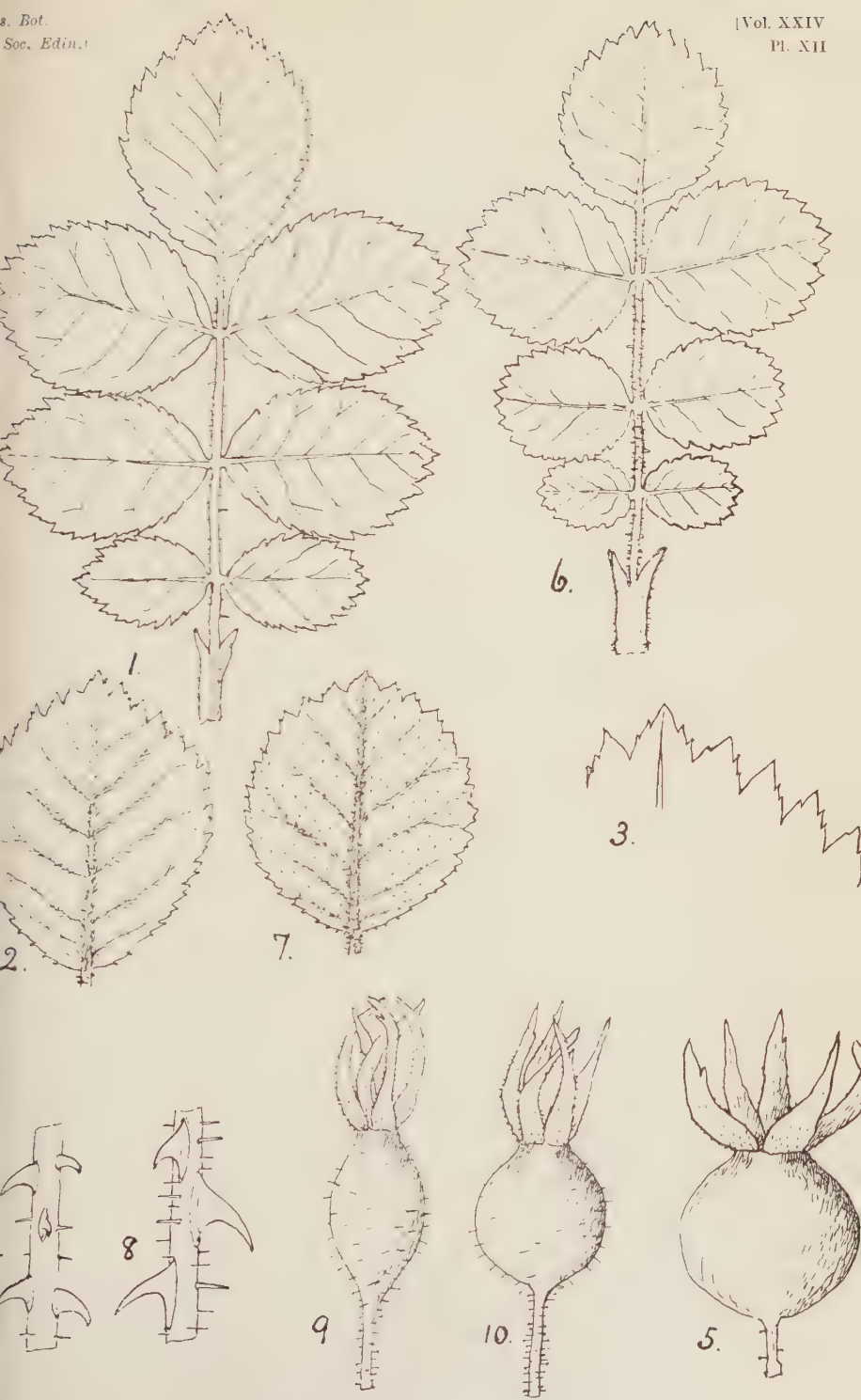
EXPLANATION OF PLATE.

FIGS. 1-5. *Rosa hibernica*, nov. var., from Port Seton.

1. Leaf, $\times 1\frac{1}{2}$. 2. Leaflet, underside, showing clothing, $\times 2$. 3. Leaf margin, $\times 5$. 4. Portion of branch, showing prickles, $\times 1$. 5. Fruit, $\times 1\frac{1}{2}$.

FIGS. 6-10. *Rosa pimpinellifolia* $\times$ *rubiginosa*.

6. Leaf, $\times 1\frac{1}{2}$. 7. Leaflet, underside, showing clothing, $\times 2$. 8. Portion of branch, showing prickles, $\times 1$. 9. Fruit, elongated form, $\times 1$. 10. Fruit, round form, $\times 1$.



THE GRASSLAND OF ORKNEY: AN (ECOLOGICAL ANALYSIS.
By G. W. SCARTH, M.A.

Prefatory Note.

This paper is only part of a systematic ecological study, not yet completed, of all the land vegetation of the Orkney Islands, and was written with the prospect of forming a part of the complete description. It has been suggested to me, however, that, as the ecological classification of Grassland is in a very chaotic state at present, this attempt at analysis may contribute a little to its advance, and might lose in value by being kept back too long.

I have therefore decided to publish it separately, but have not greatly changed the original working, as there is still a possibility of its being incorporated in the whole work. Some of the references may thus be rather unintelligible at present.

While it is hoped that the main features of the classification adopted are fundamental, great accuracy of detail is not claimed, for this is really only part of a primary survey of an extensive area, and there was no time for soil analysis and other operations of a detailed survey.

The division grassland is, on the whole, a natural one in ecological classification, though its extent and limitations are arbitrary. In some regions extensive tracts of natural or primitive grass vegetation may occur, but under other climatic conditions most of the grassland is of semi-cultural origin.

Grassland may be defined from the other main divisions of vegetation by the following characters:—

1. The soil, as regards moisture conditions, ranges from one which is quite dry in summer to a permanently wet soil, not, however, so wet as a marsh.

2. The soil is generally loamy. There is at least no distinct formation of peat. The soil may contain a certain amount of raw humus and may even overlie a considerable depth of peat, but in the latter case it is safe to assume that the peat was formed when some other formation occupied the field.

3. The grasses usually dominate, or plants generally associated with the grasses.

Extensive grassland, either meadow or pasture, is not common in Orkney. The climate is too favourable to the production of acid humus for these mesophytic types.

Consequently, on the low grounds, after the surface of a marsh has been raised sufficiently above the water-table for meadow to develop in a region of hotter and drier summers, the sedges continue to dominate until peat moor and heath plants appear. On drier ground again the natural vegetation is also heath or moor. We have seen that there may be a certain development of grassland on the links and by the seaside generally, which, though encouraged by grazing, is probably of natural origin. But with this exception practically all the pastures owe their existence to human influence. Specifically the following are the main factors involved in the production of grassland out of the natural formations:—

Heather-burning; grazing, treading, and manuring by domestic cattle; drainage; cultivation; spread of grass seeds from cultivated land and other grassland.

Without in the meantime attempting to classify them, I shall enumerate the chief situations where through natural or artificial causes, the grasses dominate.

The Stations.

Stream sides.—For a short distance on either side of a stream that overflows its banks occasionally there is the requisite moisture for the formation of a meadow, and, owing to the draining influence of the channel of the stream, there is no stagnation and consequent souring of the soil. A narrow strip of meadow may thus be formed, but further from the stream sedges dominate.

Small islets in the lochs.—In this very limited type of locality somewhat similar conditions hold and similar vegetation results. Manuring by waterfowl and absence of grazing aid in encouraging the growth of tall herbs, such as *Spiræa* and *Angelica*.

Grassy banks.—On sloping sea-cliffs on sheltered coasts where there is little salt spray, and on similar inland slopes, of which there are few, the perfect drainage permits a grassy formation, as a rule, though not always, to oust the heath.

Moist grass slope.—Strips of green may sometimes be seen running down a hillside, which exhibit on closer

investigation a close-cropped grass sward with a good deal of *Carex panicea* and *C. glauca* in some cases, or even a dominance of these. These grass strips seem to be due to gentle springs and rapid movement of water keeping the soil fresh. A somewhat similar grass slope may occur at the base of Alpine rocks and in the neighbourhood of Alpine rills: but there is little of Alpine conditions in Orkney.

Marsh-meadow of the lowlands.—While the evolution of a marsh never results in the production of a pure meadow in Orkney, it sometimes gives rise to a formation in which the grasses dominate over the sedges and other marsh plants. Such a type we may call a marsh-meadow, but this will be referred to again.

Wet springy hollows.—The brown colour of the moorlands is occasionally interrupted by green patches, chiefly in the valleys, where abundant movement of spring water or drainage water gives rise to a type of vegetation varying from simple marsh to a heathy pasture, but the bulk of which is akin to a marsh-meadow.

The above are all more or less natural situations as described, but can rarely be found uninfluenced by grazing, drainage, etc. They are of very limited extent.

The following are more directly due to man's influence—still not including land in regular cultivation:—

Drained marshes and wet ground formerly cultivated but long left untended.—Such areas develop into various kinds of marsh-meadow after some time.

Dry permanent pastures either on ground formerly cultivated or on very old pasture ground, such as the vicinity of farm steadings and the borders of fields, where the various factors previously mentioned, grazing, spread of seeds, etc., are most active.

Grassy heath or heath pasture, where persistent heather-burning and long-continued pasturing have resulted in the heath grasses dominating over the heather.

Besides the above there are grasslands which owe their existence to marine influence, and thus belong to the coast formations. They are probably the only types that would occur to any extent in a state of nature.

For the sake of completeness I briefly refer to them here also.

Calcareous meadow.—In the island of Sanday especially, the low ground round the fresh-water lochs has no sedge vegetation. *Equisetum limosum* swamp passes directly into grass meadow. This appears to be due to the fact that the soil consists of shell sand mostly and is continually receiving a wind-blown deposit of carbonate of lime in this form. The formation of acid humus is thus prevented.

Sand meadow and sand pasture.—The fine pasture ground that is associated with sand dunes is no doubt partly due also to the neutralising action of blown shell sand, as well as to the drainage effected by the porous nature of the soil. The pasturing of sheep and cattle, as well as the manuring by seaweed where spread out to dry for kelp-burning, have helped to develop this form of grassland. It is described under the Psammophytic Formations.

Maritime pasture.—The grassy areas near the sea on exposed coasts appear to owe their existence to the presence of wind-carried salt in the soil. Sheep pasturing and sea-fowl guano have helped to enrich the soil. Both this and sand pasture are characterised by having *Festuca rubra* as the dominant plant. In the present case, however, it tends to pass landward into a heathy pasture, with *Nardus* dominating.

The Formations and Associations.

In attempting to classify the various types of grassland it is not easy to employ with success the designation *meadow* and *pasture*, because there is much wet ground which, in an ecological classification, would be placed along with meadow, but which in popular speech would not receive that name. "Wet pasture" would be more suitable. *There are certainly two types of grassland, one with a wet soil due to ground water, the other with the moisture of its substratum derived mostly from direct precipitation.* The wet type may occur on a slope, depending on springs or the percolating water of drainage channels, as often as on a plain with a high water-table.

This appears to be the most fundamental character which can be used in classifying grassland. The chief difficulty

is to find names to distinguish the two types. Not wishing to stretch the meaning of the term meadow, I call them tentatively *wet pasture* and *dry pasture*. The definition is more important than the name.

Another factor which profoundly influences vegetation is the acidity or otherwise of the soil. It appears clear that, although grassland is regarded as typically mesophytic, many soils with acid humus support associations which are best described as grassland. On the other hand, grassland is common on calcareous soils, which may have an alkaline reaction.

Since these variations of soil occur both with wet and dry substrata, an ideal subdivision of grassland would be as follows:—

I. Wet pasture.

1. Acid.
2. Neutral.
3. Alkaline.

II. Dry pasture.

1. Acid.
2. Neutral.
3. Alkaline.

The nearest approach to this that can be reached in classifying the actual associations that occur is as follows. I give simple descriptive names to the various divisions. Fuller definitions follow.

I. WET PASTURE FORMATION.

Sub-formation I.—Marsh-meadow and wet pasture (grass sedge and *Juncus* types).

Sub-formation II.—Neutral meadow (negligible in Orkney).

Sub-formation III.—Calcareous meadow.

II. DRY PASTURE FORMATION.

Sub-formation I.—Heath pasture.

Sub-formation II.—Neutral pasture.

Sub-formation III.—Sand pasture.

Sub-formation IV.—Maritime pasture.

Sub-formations III. and IV. are excluded as belonging to other formations.

Possibly calcareous pasture on limestone and chalk might form a *sub-formation III.* in other areas, but there is none such in Orkney, and I have not studied it anywhere.

FORMATION I.—WET PASTURE.

Owing to ground water from whatever cause, the sub-soil is not dry even in summer. No determinations of water content were made, so I am not yet able to compare in this respect the wettest ground that I include as wet pasture with that of a marsh, but apparently in some cases the soil may be as wet as in the latter, but is less stagnant and probably richer in food salts. Of course the line of separation is purely arbitrary. The distinction that I usually employed lay in the vegetation, viz. *the dominance of the grasses*. In a few cases perhaps where they are not dominant the abundance of *Trifolium repens* suggests meadow rather than marsh.

As regards the division into sub-formations tabulated above, it can scarcely be said that the distinction "acid" and "neutral" is rigid in my grouping of the associations in I. and II.

Soils too *wet* as well as too acid for true meadow are included in the "Marsh-Meadow and Wet Pasture" division.

The distinction in the character of the vegetation is *the presence in I. of a large percentage of marsh plants or sometimes plants of wet heath*.

It was found that in Orkney true neutral meadow could be recognised occupying only **very limited areas**.

Nor was there any very characteristic association on these areas that could not be referred either to marsh-meadow or to neutral pasture (dry). I have therefore decided to omit any special description of neutral meadow, on the basis of the limited material afforded for its study in Orkney.

As a consequence some of the types described under sub-formation I., such as the *Aira caspitosa* association, ought perhaps to be referred to sub-formation II.

Sub-formation III., *calcareous meadow*, is a very distinct type on the other hand.

Sub-Formation I.—Marsh-Meadow and Wet Pasture.

This includes two types: low-lying wet ground with a high water-table, to which the term marsh-meadow is most applicable, and sloping drainage channels or ground in the vicinity of springs, more naturally described as wet pasture. But there is no essential difference in the vegetation which would make it possible to separate them. The first type especially is closely allied to a true marsh and grades into it, but is distinguished by the dominance of the grasses as a rule, or the presence in quantity of certain distinctively meadow plants, such as *Spiraea*, *Trifolium repens*, etc. On the other hand, the distinctive marsh plants, such as sedges and species of *Juncus*, are never absent, and are usually prominent.

This is obviously an intermediate type between marsh and meadow, but in Orkney at least cannot be described as a transition, because it practically never does pass into meadow. It is, moreover, a common, if not extensive, type of vegetation and requires independent notice.

Just as two types of marsh are recognisable—"rich marsh" on deeper and more fertile soil, and "poor marsh" on poor ground—so there are two corresponding forms of marsh-meadow. On a firm infertile clay or sometimes peaty soil similar to that which bears a "panicetum," but further from the water-table, a grass association may occur which might correspondingly be called "poor marsh meadow" or "poor wet pasture."

In contrast to typical marsh-meadow, which has a fairly luxuriant growth, including tall herbs, such as *Spiraea* and *Angelica*, *poor marsh-meadow* has an extremely short sward with much *Carex panicea* and *glauca*, and many rosette plants. The most characteristic brightly flowering herb is *Leontodon autumnale*, the presence of which may be used to distinguish it from poor marsh, into which it grades. Like its corresponding marsh type, it may occur on sloping as well as horizontal ground. The green strips already referred to as "moist grass slope" consist of a vegetation similar to the poor marsh and poor marsh-meadow of

the clayey flats. Probably the excessive movement of water in such places causes leaching of the soil, as well as comparative freedom from acid humus. The short herbage and firm soil, in spite of its wetness, make it difficult to appropriately apply the term meadow to this type of wet pasture either on the plains or hillsides. It cannot be mown. It grades imperceptibly into dry pasture on similarly poor ground, and differs in little but the presence of glaucous sedges.

Tussock (or Juncus) type of wet pasture.—A third type of wet pasture is that characterised by the presence of taller and deeper-rooting plants such as *Juncus communis*, interspersed usually as tufts among a shorter vegetation. These deep rooters are more or less helophytic, but as they penetrate into the subsoil they are indifferent within wide limits as to the height of the water-table, and may thus have associated with them, and occurring as an association between the tufts, surface-rooting plants of widely different character, from semi-aquatic to inhabitants of dry soil.

Occasionally we find a closed association of *Juncus* and the like. It might therefore be argued that a meadow with tufts of *Juncus* is merely a transition, or a mixed association, passing over to a closed *Juncus* association. When we consider the reciprocal relationship of the grass type and *Juncus* type, it becomes apparent that a combination of the two gives the maximum vegetation on a given area, because they tap different layers of soil and are thus not entirely rivals. Owing to its growth form, *Juncus* remains in tufts instead of becoming uniformly intermingled, but nevertheless it seems better to regard the whole as a composite association, comparable to a wood with its undergrowth, rather than a mixture of associations. The varying nature of the undergrowth, however, lends difficulty to the description as a single association.

Vegetation of Marsh-Meadow.

The accessory plants vary greatly in the different types of marsh-meadow just described. (1) In the *Juncus* type they include many plants of wet heath. (2) In "poor

marsh meadow" the species are few. Besides the dominating *Agrostis* or *Nardus* and the sub-dominant *Carex panicea* and *C. flacca*, the following are common: *Molinia caerulea*, *Plantago maritima*, *Triodia decumbens*, *Leontodon autumnale*, *Bellis perennis*, *Prunella vulgaris*, *Euphrasia officinalis*, *Scabiosa succisa*, *Parnassia palustris*, *Anagallis tenella*, *Carex pulicaris*, *Viola palustris*, and orchids. These are mostly prostrate, stunted, or rosette forms, in keeping with the short sward of the association. They may be analysed into plants of poor marsh-meadow and of poor pasture.

(3) In the more luxuriant marsh-meadow there are two types which present a very different aspect—a wetter type, which is usually mowed regularly, and has, in consequence, a *close, regular growth of Glaniflora*, with few tall herbs; and a drier type, *diversified by many tall plants*, many of them *with showy flowers*.

The important grasses are—*Agrostis alba*, *A. vulgaris*, *Holcus lanatus*, *Aira caespitosa*, *Anthoxanthum odoratum*, *Nardus stricta*, *Cynosurus cristatus*. Others are occasionally present—*Poa pratensis*, *Triodia decumbens*, *Digraphis arundinacea*. The dominant species are *Agrostis alba*, *A. vulgaris*, *Holcus*, or *Nardus*. Sub-dominant are usually sedges *Carex vulgaris*, *C. flava*, and *C. pulicaris*.

Accessory Plants.—Some are fairly characteristic of the formation—*Spiraea ulmaria*, *Angelica sylvestris*, *Rhinanthus Crista-galli*, *Senecio aquaticus*, *Geum rivale*, *Scabiosa succisa*, *Achillea ptarmica*, *A. millefolium*, *Sagina nodosa*. There are also marsh plants—many species of *Carex*, *Juncus articulatus* (agg.), *J. conglomeratus*, *Equisetum palustre*, *Ranunculus flammula*, *Carduus palustris*, *Potentilla comarum*, etc.; and pasture plants—*Trifolium repens*, *T. pratense*, *Lathyrus pratensis*, *Prunella vulgaris*, *Plantago lanceolata*, *Primula vulgaris*, etc.

The chief mosses are Hypneae. See examples for further species.

Associations of Marsh-Meadow and Wet Pasture.

The tufted types described are peculiar in their mode of occurrence, but may be described as associations. Elsewhere the grass which usually dominates is some species of

Agrostis. The only other grass that dominates over any considerable area is *Nardus stricta*. It affects the more peaty soils, not, however, extremely wet. *Holcus lanatus* may sometimes dominate, but its dominance does not seem to be of sufficiently definite occurrence to merit rank as an association, nor in growth form is it so divergent from the *Agrostis* type as *Nardus*.

We may thus recognise two broad associations, apart from the tussock forms: one, characterised by *Agrostis*, in which *helophytic* characters are the most distinct feature, not properly belonging to meadow: the other, characterised by *Nardus*, in which *oryzophytic* characters take a similar place.

Since both grasses may dominate in other situations than marsh-meadow, the associations here found have their distinguishing character indicated by introducing the word "Carex" into the name.

1. *Agrostis*-Carex association.
 - 1a. *C. panicea* variety.
2. *Nardus*-Carex association.
 - 2a. *C. panicea* variety.
3. *Aira cæspitosa* association.
4. *Juncus conglomeratus* association.
5. *Iris* association.

1. *Agrostis*-Carex association.—The dominant grass is one or other species of *Agrostis*. *Agrostis alba* is more characteristic of the wet soil of this formation than *A. vulgaris*, but the latter also occurs. (The two species appear to grade into one another. I cannot always distinguish them.) *A. alba*, var. *stolonifera*, is very often dominant.

Sedges are usually sub-dominant. In soft wet soil the species is usually *Carex vulgaris*; on firm soil, clayey or peaty, it is characteristically *Carex panicea*, accompanied by *C. glauca*. The first type is allied to "rich marsh" and passes into it, the second to "poor marsh."

These glaucous sedges may occur also in the more luxuriant type of marsh-meadow, but there are other distinguishing features in the vegetation as well which mark out the *Agrostis*-Carex *panicea* association as a

distinct variety, viz. the shortness of the sward and the absence of tall Dicotyledons as a rule. The central type, on the other hand, may have several storeys of vegetation.

2. *Nardus-Carex association*.—Here also there are the two types "rich" and "poor." In the first case *Carex flacca* is perhaps most characteristic; in the second the glaucous sedges, as before.

Perhaps in both cases the soil is more peaty than in the *Agrosti-Cladonia*, but is never so wet as the latter sometimes is. The tendency is to pass into heath, and this is forecasted even in the moistest conditions in the characteristic abundance of *Scabiosa succisa*.

The *panicula* variety often occurs in tussock form, *Nardus* dominating on the little hummocks, and the glaucous sedges on ground between them.

3. *Aira caespitosa association*.—This is one of the tussock forms previously discussed, which may occur as an almost pure association, but more commonly interspersed throughout some other association. The intervening vegetation may vary widely in character, from semi-aquatic, with *Menyanthes* and the like, to apparently dry pasture. *Aira* appears, however, to depend on a wet subsoil, and it is a common sight in some districts to see good pasture ground, in need of drainage, becoming worthless through the encroachments of this useless plant. The soil characters of this association place it rather in sub-formation 2, but it scarcely seems worth while detaching it from the allied associations that follow.

4. *Juncus conglomeratus association*.—*Juncus* resembles *Aira caespitosa* in forming tufts, but does not rise into tussocks as the latter sometimes does. Abundance of *Juncus* tufts is specially characteristic of wet ground which has once been cultivated but allowed to lie fallow for some time—i.e. as a retrogressive association. After many years plants of peat moor and moist heath begin to appear, such as *Eriophorum angustifolium*, *Calluna*, *Erica*, etc., but this is rarely allowed to happen.

A *Juncus* association is also the most frequent in the station described as "wet springy hollows." In this situation it is a natural product.

5. *Iris association*.—Like *Juncus conglomeratus*, *Iris*

pseudacorus is also really a marsh plant, but owing to its deep rooting it may invade plains sufficiently high above the water-table for grasses to dominate.

Sub-Formation II.—Neutral Meadow.

Extremely local. What occurs may be regarded as a variety of marsh-meadow without sedges or as neutral pasture. This type is rich in species. See example 10.

Sub-Formation III.—Calcareous Meadow.

This, as mentioned previously, is a special type occurring locally, where there is much shell sand deposited by the wind. The effect of this constant supply of calcium carbonate is to render the soil alkaline. The result is a very marked difference in the marsh vegetation in such areas from that of the ordinary type, the most striking being the practical absence of sedges. The characteristic sedges of the alkaline Fens of England do not occur in Orkney, or they might have been found here, but the soil is evidently not suited for the indigenous species. *Equisetum limosum* is usually the dominant plant, with much *Agrostis alba*, and in passing to drier conditions the grass gradually assumes dominance. At higher levels other grasses appear and many marsh-meadow plants, but still as a rule no sedges. A *Poa pratensis* association was observed in one fairly dry place, but as a rule the meadow consists of little but *Agrostis alba*—with *Equisetum limosum* as it grades into marsh. To distinguish it we may call this:—

1. *The Agrostis-Equisetum limosum association.* See examples 11 and 12.

FORMATION II.—DRY PASTURE.

Grassland in which the bulk of the soil water is derived from precipitation and not added to by springs or drainage from elsewhere.

The usual aspect of the vegetation is that of an even sward, starred, it may be, with flowers of dicotylous and monocotylous herbs, which do not, however, rise to any great height. The most characteristic are in fact of more

or less rosette habit, such as *Bellis perennis*, *Leontodon autumnale*, *Hypochaeris radicata*, *Ranunculus acris*, *Plantago lanceolata*; or procumbent, as *Trifolium repens*, *Thymus serpyllum*, *Luzula campestris*, *Scabiosa succisa*.

In fact, in farm-yards where the ground is very much trodden by fowls and other animals, the rosette forms often dominate, especially *Bellis* and *Plantago major*. *Rumex obtusifolius* is also characteristic of such situations.

That this character of the vegetation is in part at least the result of the grazing and treading of animals, and perhaps of exposure to wind, is also shown by the divergent physiognomy exhibited by pasture on steep slopes and by dyke-sides along fields, etc., where these factors operate to a less extent or not at all. There the vegetation is taller, and plants of varying height go to make it up, *eg.*—

Tall.—*Heracleum sphondylium*, *Anthriscus sylvestris*, *Angelica sylvestris*, *Senecio aquaticus*, *Sonchus oleraceus*, *Lychnis dioica*.

Intermediate.—*Plantago lanceolata*, *Galium verum*, *Achillea ptarmica*, *A. millefolium*, *Leontodon autumnale*, *Hypochaeris radicata*, *Lathyrus pratensis*, *Vicia cracca*, *V. sepium*, *Trifolium pratense*.

Short.—*Trifolium repens*, *Lotus corniculatus*, *Cerastium triviale*, *Thymus serpyllum*.

In addition to this the taller grasses occur only in such places, *eg.*—

Avena elatior, *Festuca pratensis*, *Dactylis glomerata*, *Phleum pratense*, *Alopecurus pratensis*.

These of course are grasses of the cultivated land (fodder or weeds), and it is only as strays that they occur at all outside of it.

Associations.

Sub-formation I.—Heath pasture.

1. *Nardus* association.
2. *Agrostis*-*Calluna* transitional association.
3. *Pteris* association.
4. *Luzula sylvatica* association.

Sub-formation II.—Neutral pasture.

1. *Cynosurus*-*Agrostis* association.
2. *Poa pratensis* association.

Sub-formation III.—Sand pasture.

1. *Festuca rubra* association.

Sub-formation IV.—Maritime pasture.

1. *Festuca rubra* association.

Sub-Formation I.—Heath Pasture.

This type of formation is also termed grass heath, and grouped along with shrub heath, etc., regard being had chiefly for soil character. Laying more stress on the physiognomy of the vegetation, it may be permissible to include it with other grassland.

It is not natural to Orkney. Only through repeated burning of the heather and long-continued pasturing of sheep or cattle has Calluna in a few places given way to *Nardus* or *Agrostis*. This has been most completely attained on a steep northern slope where direct sunshine is at a minimum, such as the north slope of Kierfea Hill, Rousay.

A certain geological formation seems also to favour *Nardus*. A certain section of the Rousay beds, characterised by the formation of terraced hillsides, tends throughout its range in Westray, Rousay, and Evie to bear a heath with sub-dominant *Nardus*.

At first sight the practical absence of grass heath in Orkney seems remarkable since most of the Faeroes is covered by it. Ostenfeld is inclined to lay more stress on the insular climate than on the geological factor—the basaltic rock—as the cause of the great development of “grass-moor” in the Faeroes, but, having regard to the distribution of heath pasture and Calluna heath in the Scottish Highlands, the great importance of the chemical nature of the rocks is apparent. There, as pointed out by Robert Smith, pasture occurs on the rich schists, and heath on poor sandstones, quartzites, etc. The arenaceous and argillaceous sedimentary rocks of the Orkneys bear a somewhat similar relation in chemical constitution to the basalts of the Faeroes, as do the two types above to one another.

Ostenfeld's association of *Nardus* along with *Juncus squarrosus* and *Scirpus caespitosus* as “grass moor” will be discussed further in treating of the “moorlands.”

Four associations may be recognised:—

1. *Nardus* association.
2. *Agrostis-Calluna* association (transitional).
3. *Pteris* association.
4. *Luzula sylvatica* association.

The third and fourth are of scanty occurrence.

1. *Nardus* association.—Occurs usually on dry soil, but, from the stunted growth of accessory plants, not apparently very rich. *Nardus* dominates. Other grasses, such as *Agrostis vulgaris* and *canina*, *Aira caespitosa*, *A. præcox*, and *A. flexuosa*, *Anthoxanthum odoratum*, *Holcus lanatus*, and *Triodia decumbens*, occur in varying proportions. *Calluna* is often sub-dominant. *Juncus squarrosus* may be so in places. The accessory plants are those of dry heath—*Potentilla tormentilla*, *Erica cinerea*, *Empetrum*, etc.

2. *Agrostis-Calluna* association.—On richer soils. Also entirely of artificial origin. Dominant, *Agrostis vulgaris*. Other grasses, *Agrostis canina*, *Triodia decumbens*, *Anthoxanthum*, *Holcus*, *Aira flexuosa*, *A. caespitosa*, etc. etc.

Calluna in vigorous clumps usually, and *Erica cinerea* also luxuriant. These are kept down by burning periodically. A great variety of heath and pasture plants may be present.

This is a transition to the more widespread *Cynosurus-Agrostis* association of less acid soil, and scarcely merits the rank of association.

3. *Pteris* association.—*Pteris aquilina* is not abundant in Orkney, and as a dominant plant it is rare. Its preference for a sunny southern slope is rather peculiar in view of its frequently sylvan habitat in the South. This association may be seen in Flotta, and mingled with *Calluna* in several places *eg.*, Berriedale, Hoy, and Firth parish. What determines its presence I have not endeavoured to find out.

4. *Luzula sylvatica* association.—*Luzula sylvatica* often dominates on steep slopes. *Calluna* is frequently present; in other cases grasses are associated with the dominant plant.

Sub-Formation II.—Neutral Pasture.

When the agencies so frequently referred to have acted so long or so thoroughly as to banish all peaty character

from the soil, heath plants disappear and other species take their place, such as were mentioned in describing dry pasture in general.

Two associations at least may be recognised:—

1. *Cynosurus-Agrostis* association (the usual one).

2. *Poa pratensis* association (rich old pasture).

1. *Cynosurus-Agrostis vulgaris* association. — *Cynosurus* and *Agrostis vulgaris* are the dominant grasses in the great bulk of pasture land in the islands. They usually occur together, and in some respects it is a natural coalition, because *Cynosurus* is as early a grass as is suitable for the late northern springs, while *Agrostis* is very late and may remain green all winter. This is even more marked in *Agrostis alba*, which is also prominent, especially in wetter situations. In the better pastures *Cynosurus* may dominate almost to the extinction of *Agrostis*, and, on the other hand, is often absent on poorer ground, especially if there is a tendency to the development of raw humus in the soil. But the individual dominance of either is so much rarer than the combination of both in more or less equal quantities, that it is better to regard the common type as a *Cynosurus-Agrostis* association, especially since the union gives an association with a longer vegetative period and a greater production of material. There may be differences in their food demands also; at any rate their relationship is not one of entire rivalry.

R. C. Gaut, in the "Botanical Survey of a Pasture" (*Naturalist*, 1904), concludes that *Cynosurus* is characteristic of poor soils. This appears contradictory to the fact that *Cynosurus* forms most of the best natural pasture in Orkney, but the two conclusions are not irreconcilable. In England, *Cynosurus* may be driven to the poorer soils by competition of the lustier grasses, Fescues, Foxtail, and Cocksfoot, but in Orkney, owing to climatic causes probably, they do not enter into competition. Meadow Fescue, in fact, grows very poorly even when sown in cultivated land.

Holcus lanatus is usually an important constituent of this association. It tends to grow in patches. It may even *dominate*, but associated with *Agrostis* rather than *Cynosurus*.

Anthranthum odoratum is frequently a sub-dominant.

Many varieties of the association might be distinguished, for it has a wide range.

One of the commonest forms, characteristic of rather poor pasture, has little or no *Cynosurus* and an abundance of *Leontodon autumnale*. On wetter ground this *Leontodon* variety contains *C. pinnica*, etc., as well, and becomes "poor wet pasture." Rich pasture may, on the other hand, have little *Agrostis* and *Leontodon*—the *Cynosurus* variety.

On steep grassy banks the taller and more varied assemblage of plants described previously may usually be regarded as a third variety of the *Cynosurus-Agrostis* association.

The subordinate plants in this association have been largely enumerated in speaking of the formation as a whole. Others are mentioned in the examples below. On certain soils a thick springy turf of *Hypnum* obscures the grasses in winter time.

2. *Poa pratensis* association. —In the richest old pasture, which is also sheltered from the biting spring winds, a more southern type of pasture may occur than is usual in Orkney. *Poa pratensis*, being usually abundant, may give its name to the association, but over small areas various grasses may dominate. *Lolium perenne*, *Agrostis*, *Holcus*, and *Cynosurus* are abundant, as well as *Poa*, while *Alopecurus pratensis* and *Phleum pratense* reproduce themselves naturally in such quarters. Rye-grass, Timothy, and Fox-tail are not indigenous in Orkney.

The accessory plants with bright flowers are also different in this association from what is found in the preceding one.

Ranunculus acris takes the place of *Leontodon*, and, along with *Bellis*, gives colour to the field.

Trifolium repens is very abundant in this, as in richer forms of the *Cynosurus-Agrostis* association.

Sub-Formations III. and IV.

"Sand Pasture" and "Maritime Pasture," as already stated, are included in another œcological section.

The Successions.

A study of the successive changes which take place in the conversion of natural formations into grassland, and

the relapse of untended grassland, involves too much reference to other formations to be undertaken in this paper.

Examples.

Having personally been much assisted in arriving at a vivid conception of the vegetation of the areas described by the system of illustrative examples adopted by some ecological writers, I follow their example and append a few of actual notes taken on typical sites. The notes are rudely arranged, according to the foregoing scheme of classification.

I.—MEADOWS AND WET PASTURES.

i. Acid to Neutral.

1. *Boardhouse Loch, below Twatt*.—Level ground formed through lowering of the level of the loch by deepening the exit. Driest parts: *Agrostis* (2 sp.) dominates. *Anthoxanthum* sub-dominant. *Holcus*, *Nardus*, and *Cynosurus* are present, and *Carex glauca* abundant. *Senecio aquaticus*, *Leontodon autumnale*, *Rhinanthus Crista-galli* and *Prunella vulgaris* give colour to the meadow, while *Ranunculus acris*, *Spirea ulmaria*, and *Orchis maculata* would have done so earlier in the season. Also present: *Achillea ptarmica*, *Bellis perennis*, *Sagina nolosia*, *Mentha aquatica*, *Galium uliginosum*, *Scabiosa succisa*, *Callitha palustris*, *Plantago maritima*.

A few inches lower, *Carex glauca* dominates and grasses are few.

2. *Another part of the same lochside*.—Soil a clayey deposit 6 inches to 1 foot deep. Considerable organic matter. No reaction to litmus paper. Earthworms present. Sward short and close. *Carex glauca* and *panicea* and *Nardus* dominate. *Plantago maritima* sub-dominant. *Triodia decumbens*, *Juncus articulatus*, *Molinia cerulea* in some quantity. *Agrostis* and other plants occasional. Brightly flowering herbs in order of frequency: *Leontodon autumnale*, *Prunella vulgaris*, *Bellis*, *Euphrasia*, *Scabiosa succisa*, *Anagallis tenella*, and *Parnassia palustris*.

3. *Folster Meadows, Birsay*.—East end was formerly cultivated, but has long lain fallow. Dominant: *Agrostis* (2 sp.) and *Aira cespitosa* in places. In other places *Nardus stricta*. *Nardus* in drier but perhaps sourer conditions. *Spirea* abundant near streams. *C. glauca* is common; others are *C. panicea*, *C. flava*, *C. vulgaris*, *C. puberis*, and *C. dioica*. Other plants: *Senecio aquaticus*, *Achillea ptarmica*, *Leontodon autumnale*, *Plantago lanceolata*, *Ranunculus acris*, *Prunella vulgaris*, *Luzula campestris*, *Scabiosa succisa*, *Rumex acetosa*, *Juncus conglomeratus*, *Cnicus palustris*, *Rhinanthus Crista galli*, *Potentilla anserina*.

In wetter parts *Aira* disappears.

4. *Flats below Inpsay, Birsay*.—Whole area on a deep clayey marsh peat. Site of a former loch. Ditched. Parts drained and cultivated.

Uncultivated parts:—

(1) *Meadow of Bea*. The following rudely in order of frequency: *Carex vulgaris*, *Equisetum palustre*, *Juncus articulatus*, *Trifolium repens*, *Holcus lanatus*, *Potentilla comarum*, *Menyanthes infoliata*, *Hydrocotyle vulgaris*, *Agrostis alba* and *vulgaris*, *Molinia cerulea*,

Triodia decumbens, *Festuca ovina*, *Ranunculus acris*, *Senecio aquaticus*, *Triglochin palustre*, *Pedicularis palustris*, *Leontodon autumnale*, *Caltha palustris*, *Anagallis tenella*, *Scabiosa succisa*, *Lychnis flos-cuculi*, *Prunella vulgaris*, *Luzula campestris*.

(2) Ditches with *Glyceria aquatica* and *Iris*.

(3) Tableland of peat with *Calluna* dominating. *Nardus* and *Agrostis* sub-dominant.

(4) South side. Tussocking poor marsh-meadow, with *Nardus* on tufts. Glaucous sedges and *Molinia*, etc., between.

5. *Meadow near Orquill, St. Ola*.—Ditched. *Holcus* and *Nardus* dominate. *Carex*, chiefly *flava*. Also *C. glauca*, *Juncus communis*, *Agrostis*, *Trifolium repens*, *Juncus squarrosus*, *Equisetum palustre*, *Caltha palustris*, *Ononis palustris*, *Pedicularis palustris*, *Scabiosa succisa*, *Senecio aquaticus*, *Leontodon autumnale*, *Achillea ptarmica*, *Ranunculus flammula*, *R. acris*, *Potentilla anserina*, *Rhinanthus Crista-galli*, *Comarum*, *Spiraea*, *Lychnis flos-cuculi*, *Luzula campestris*.

Other *Carex*-es, *Juncus articulatus*, etc., appear in the transition to the marshy depressions.

6. *Flats, Birsay*. In some parts a lumpy surface, with *Nardus* on the hummocks. Glaucous association of poor marsh between. *Nardus*, accompanied by *Viola palustris*, *Prunella*, etc.

7. *Hillside south of Finstown*.—The general surface of grassy heath is interrupted by green strips of short cropped pasture running down the hillside. *Agrostis* apparently dominates (no inflorescences). A large amount of *Leontodon autumnale*. Sometimes glaucous sedges, but no heath plants. These strips appear to be due to gentle springs giving a moist, non-acid soil.

8. (a) *Juncus pastures near Scapa*.—Once cultivated. Drained. Firm, level surface, dry in summer, but may be flooded after heavy rains in winter.

Juncus in tufts, but in places occupies greater part of surface. On firmer ground *spiral variety* of Rush dominates. Between the tufts glaucous sedges may dominate in parts, with a few grasses, *Holcus* and *Cynosurus* chiefly. *Senecio aquaticus* is common and the usual plants of marsh-meadow.

In other places there is a *Carex vulgaris* marsh between the *Juncus* tufts.

In others grasses dominate, especially *Holcus lanatus* and *Agrostis stolonifera*. There is an undergrowth of *Hypnum* everywhere.

(b) *Permanent pasture on adjoining hillside*.—*Juncus* tufts extend up wet parts, with intervening *Cynosurus* or *Holcus*, etc., dominating.

9. *Wet springy valley in heather moorland, Holm Hills*.

Vegetation. Wet heathy pasture with much *Juncus*. No individual plant distinctly dominates over any wide area. *Juncus communis* is most prominent in some places, *Aira cespitosa* in others, and *Calluna* in others, this only of local occurrence. The following also struggle for supremacy: *Nardus stricta*, *Agrostis alba*, *A. vulgaris*, *Carex pulicaris*, *C. flava*.

Other grasses, especially *Holcus lanatus*, and other sedges, especially *C. glauca*, also occur. Present also: *Scabiosa*, *Potentilla tormentilla*, *Senecio aquaticus*, *Trifolium repens*, etc.

A dense undergrowth of *Hypnum* and locally of *Sphagnum*.

The *Juncus* is here fairly evenly distributed and not so tufted as on firmer ground.

10. *Stream-side, Dorkdale, Birsay*.—Stream flows in deep channel through valley. Succession of vegetation from stream-side:—

(1) Willows on stream bank.

(2) Strip of dry pasture.

(3) Meadow with tall herbs.

(4) Marsh-meadow.

(5a) Marsh.

(6) Plateaux of peat moor resting on marsh.

(5b) Strips of marsh at base of surrounding hills.

(7) Hillsides with heath and moor.

The meadow and pasture zone has *Agrostis vulgaris* dominant. Prominent *Cynosurus*, *Anthoxanthum*, *Holcus*, *Agrostis alba*. *Spiraea* abundant.

Accessory: *Iris pseudacorus*, *Rhinanthus Crista-galli*, *Scabiosa succisa*, *Juncus articulatus*, *Leontodon autumnale*, *Senecio aquaticus*, *Equisetum palustre*, *Ranunculus acris*, *R. flammula*, *Prunella vulgaris*, *Plantago lanceolata*, *Carex leporina*, *Hieracium sphondylium*, *Linum catharticum*, *Lathyrus pratensis*, *Trifolium repens*, *T. pratense*, *Primula vulgaris*, *Juncus conglomeratus*, *Rumex acetosa*, *Achillea vulgaris*, *Cardus palustris*.

In wet parts a tussock association of *Aira cæspitosa*, with *Spiraea*, *Juncus*, etc. There is often water between the tussocks, with *Menyanthes*, *Comarum*, *Caltha*, etc.

ii. Calcareous.

11. *Sanday*.—North Loch. Soil shell sand largely, and in region of blown sand. Marsh, with *Equisetum limosum* and *Agrostis alba*; passes into meadow, with *Ager agrostis* dominating. *Ranunculus acris*, *Trifolium repens*, *Senecio aquaticus*, *Rhinanthus Crista-galli*, etc., accompanying it, and there are no sedges.

12. *Sandy bottom of drained part of same loch*.—Well drained owing to porosity of soil, but high water-table. *Poa pratensis* dominates. *Festuca rubra*, *Trifolium repens*, *Rhinanthus*, *Parnassia palustris*, *Ranunculus acris*, *Agrostis alba* (may dominate in wetter parts or on clay), *Carex vulgaris*, *C. glauca*, *Senecio aquaticus*, *Potentilla anserina*, *Caltha palustris*, *Leontodon*, *Equisetum palustre*, *Lycalis fls cuculi*, *Sagina nodosa*.

II. DRY PASTURES.

i. Heathy.

13. *Grassy hillside south of Finstown*.—Heather kept down by burning. Much grazed over. *Agrostis vulgaris* and *A. canina* dominate. *Trionha decumbens* and *Anthoxanthum odoratum* occur, and in places *Nardus*. *Calluna* and *Erica cinerea* in vigorous clumps. Great variety of heath, pasture, and meadow plants, e.g. Willows, *Pteris*, *Spiraea*, *Scabiosa*, *Primula*.

14. *Rousay, steep northern slope of Kierfeil Hill*.—Much of it is grassy. *Nardus* and *Agrostis* dominate, with tufts of *Aira cæspitosa* and an intermingling of heath plants, such as *Empetrum* and *Calluna*.

ii. Intermediate.

15. *Field at Berstane near Kirkwall*.—High and exposed. Fallow for many years, and tending to become heathy in places.

Cynosurus is more conspicuous than *Agrostis*, owing to the smaller inflorescence of the latter, which, however, is more numerous. The following table gives the number of inflorescences of the chief grasses in several small representative areas of about a square yard in extent.

	I.	II.	III.	IV.	V.	VI.	VII.	Total.
<i>Cynosurus</i> . . .	16	24	60	0	100	10	6	216
<i>Agrostis</i> . . .	40	40	16	0	0	29	100	225
<i>Holcus</i> . . .	6	2	8	0	12	1	3	40
<i>Anthoxanthum</i> . .	20	14	20	0	0	0	60	114
<i>Festuca ovina</i> (vivip.) .	5	0	0	0	0	0	0	5

This shows how uneven the distribution of the various species is.

Other plants: *Bellis perennis* (very numerous locally), *Leontodon autumnale*, *Euphrasia officinalis* (agg.), *Trifolium repens* (local), *Aira præcox*, *Calluna vulgaris*, *Sagina procumbens*, *Luzula pratensis*, *Plantago lanceolata*, *Primula vulgaris*, *Hypochaeris radicata*, *Potentilla tormentilla*, *Pedicularis sylvatica*, *Rhinanthus Crista-galli*, *Rumex acetosella*, *Gnaphalium sylvaticum*, *Lotus corniculatus*, *Thymus serpyllum*.

It will be seen that there are many heath plants.

Agrostis vulgaris, var. *pumila*, infested by smut, is very characteristic and common on this type of pasture.

iii. Neutral.

16. Steep grassy slopes near Scapa pier.—Red sandstone.

In places *Holcus lanatus* dominant, with tufts of *Aira cæspitosa*.

In other places *Cynosurus-Agrostis* association.

Both species of *Agrostis* are present, and also *Anthoxanthum*, *Triodia decumbens*, *Poa pratensis*, and *Arrhenatherum* in small quantity. Other plants: *Plantago lanceolata*, *P. maritima*, *Lathyrus pratensis*, *Angelica sylvestris*, *Spiraea ulmaria*, *Trifolium pratense*, *Primula vulgaris*, *Senecio aquaticus*, *Ononis palustris*, *Scabiosa succisa*, *Trifolium repens*, *Lotus corniculatus*, *Thymus serpyllum*, *Erica cinerea*, *Anthyllis vulneraria*, *Linum catharticum*, *Calluna vulgaris*, *Hypericum pulchrum*, *Rhinanthus Crista-galli*, *Polygala vulgaris*, *Viola sylvatica*, *Carex glauca*.

17. (a) Walled fields near Kirkwall.—Moist natural pasture.

Poa pratensis dominant, with *Agrostis*, *Cynosurus*, *Lolium*, *Phleum*, *Alopecurus*, *Holcus*, etc. *Ranunculus acris* and *Bellis* abundant. *Trifolium repens* often dominant.

(b) Ground much trodden by hens. *Bellis perennis* and *Plantago major* are dominant. *Rumex obtusifolius* also present.

Examples would have to be greatly multiplied to illustrate the diversity of neutral pasture or to add to the general description of dry pasture given above.

THE FLORA OF THE FENLAND, AS COMPARED WITH THAT
OF THE BOGS, MARSHES, AND MOSSES OF SCOTLAND.
By ARTHUR H. EVANS, M.A.

In spite of the extirpation of certain plants by long-continued drainage, the Fenland still remains a district of much interest to British botanists, as it was to Ray and others of the olden time: for there, in a comparatively small area, are to be found a large number of species, of which some are almost restricted to it, and some do not occur elsewhere.

The Fens proper may be taken to coincide roughly with what is termed, from its scheme of drainage, the Bedford Level, and cover a large extent of flat country reaching from near St Ives in the west to the confines of Norfolk and Suffolk on the east, and from Wisbech and Peterborough on the north to within a few miles of Cambridge on the south. The Nene, the Ouse, and the Cam are the main rivers that traverse it, but the two artificial cuts, called the Old and the New Bedford Rivers, now convey most of the waters of the Ouse in a straighter course from Earith Bridge to Denver Sluice. There are also numerous wide "dikes" or "lodes," as they are locally called, with smaller cross-channels, into which the surface waters are effectually drained by means of powerful pumping engines.

Peat, lying above gault or other clayey deposits, is characteristic of the greater part of this area, but in the northern part, from Wisbech to the south of March, the soil is chiefly of the nature of silt, a fact which must be considered in connexion with the proximity of the Wash and the former course of the river Nene. Islands of clay and greensand are prominent landmarks in various places, by far the largest being the well-known "Isle of Ely." The Kimmeridge or the Oxford clay found there must not, however, be confounded with the glacial or boulder clay which tops many of the eminences surrounding the Fens, where an entirely different flora occurs, especially noted for the true Oxlip.

Fen peat is very different in appearance and composition from that of Scottish moors and mosses, being of a black

rather than of a brownish colour, and showing a decided alkaline instead of an acid reaction, while it burns with a somewhat unpleasant and by no means aromatic smell. It is composed of sedges (*Cladium* and *Carex*), reeds, grasses, hypnum, and various other plants, instead of heather, sphagnum, and the like, as in the north.¹

Whittlesey, Ramsey, Soham, and other more ancient meres have long been drained; and the only considerable piece of true fen is that adjacent to the village of Wicken, between Cambridge and Ely. A disconnected "valley fen" lies close to the village of Chippenham, and small patches of a similar nature are still to be seen at the Firelots near March, at Soham, Quy, Sawston, and elsewhere; while Woodwalton Fen in Huntingdonshire ought perhaps to be mentioned, though it can hardly be considered to fall within our limits. Almost all the Fenland proper is in Cambridgeshire, and, unless otherwise stated, all the subsequent paragraphs refer to Wicken Fen, still in a state of nature, and extending over an area of more than a square mile.²

A Fen in Cambridgeshire still means, as of old, a sedge-fen; and the general aspect of Wicken Fen is that of a fairly uniform crop of brownish sedge, some three feet high, now studded with, and in parts choked by, bushes or clumps of Willow (*Salix cinerea*), the Common and Alder Buckthorns (*Rhamnus catharticus* and *R. Frangula*), Guelder Rose (*Viburnum Opulus*), and Hawthorn. The sedge proper of the Fens—and also of the Broads of Norfolk—is *Cladium Mariscus*, said to be called the "mother sedge," though this does not appear to be a Cambridgeshire name. The wide channels of Burwell Lode and Wicken Lode bound the Fen on two sides, with smaller lodes in the other directions and cross-dikes between them. The chief waterways are continually cleaned out, and produce little of interest to the botanist except species of *Potamogeton* and *Nitella*; but

¹ My friend Dr. C. E. Moss, who has been analysing the peat, tells me that there is much more ash in that of the Fens than in that of the north, and that the former contains a great amount of mineral salts, of calcium, potassium, and sodium.

² Strictly speaking, the Fens encroach slightly on nearly all the surrounding counties, while the south of Lincolnshire consists largely of fenland. The latter, however, is hardly reckoned as part of the Fenland proper in modern parlance, probably as not being included in the same system of drainage as the Bedford Level.

the connecting dikes and ditches are very rich in plants, such as *Sium latifolium*, *Hottonia*, *Alisma*, *Sagittaria*, *Hydrocharis*, the great Water Dock (*Rumex Hydrolapathum*), and the rarer Flowering Rush (*Batium umbellatus*), together with masses of Water-lilies in places, while the great enemy of all such species is the Common Reed, which is apt to overgrow them periodically and would finally smother them if not removed.

In the ditches of the North we should expect to find quite a different set of water-plants. The place of *Sagittaria* and *Hydrocharis* is taken by *Alisma Plantago*, *Rumex Hydrolapathum* is rare and has *R. domesticus* (= *aquaticus*) for a substitute. *Batium* is almost unknown: though Water-lilies and Irises are common enough, and in the drier ditches *Sium angustifolium* represents *S. latifolium* of the Fens.

The sedge-fen itself furnishes a great variety of plant-life. In ancient times, before the mouths of the rivers were silted up to the extent of blocking the drainage of the country inland, we know that the land was more or less afforested, as oaks and other trees are dug up in the heart of the Fens, which were rooted in the tenacious soil upon which the peat was subsequently deposited. Now Willows and seedling Birches are alone in evidence, if we except the strips of Poplars planted for shelter in the cultivated land, and the various kinds of trees near the villages. As we walk up the green droves which intersect the Fen at Wicken, we have on all sides of us acres of *Cladium*, generally flowerless on the comparatively dry portions, but flowering freely in the little water-channels and ditches. Mixed with this is a large quantity of *Calamagrostis epigjos* and *C. lanceolata*, which show up more particularly where the growth has been lately cut for litter. Here, too, the main grass of the Fen, *Molinia caerulea*, has a better chance of shooting up, and our characteristic rush, *Juncus obtusiflorus*, masses itself round every water-hole or disused peat-digging. A striking feature of the ditch-sides is *Carex flata* (= *stricta*), with its peculiar tufted growth, while every here and there among the vegetation, where the reeds and bushes have not encroached, we find the Marsh Pea (*Lathyrus palustris*), the Fen Violet (*Viola*

stagnina), the Marsh Fern (*Lastrea Thelypteris*), and the Milk Parsley (*Pencelatum palustre*) on which the fine Swallow-tail butterfly feeds. Even Wicken Fen shows a tendency to dry up, though there has been very little perceptible change during the last thirty years, as the pumping-engines keep the water at about the same level; we cannot, anyhow, shut our eyes to the fact that plants of the dry land, such as *Convolvulus sepium* and *Solanum Dulcamara*, have entered the Fen from the enclosing banks and are doubtless signs of what may happen in the time to come. In the more open spaces *Ophioglossum* is not uncommon, and *Epipactis palustris* still occurs rarely, though *Menyanthes* and *Myrica* are almost wanting; on the other hand, *Valeriana dioica*, *Carduus pratensis*, *Lysimachia vulgaris*, *Lichenis Flos-cuculi*, *Orchis incarnata* and *Hydrocotyle vulgaris* are plentiful enough, as are many other species of the more ordinary marsh plants.

In Scotland the vegetation of a corresponding area cannot be so simply defined. Lowland bogs, often enclosing a piece of water, are in striking contrast with the "mosses" and "flows" of the moorlands, while swampy land on the sides of streams occurs at all kinds of elevations. Thus there is not the same uniformity of plant-life as in the Fens, which lie at or even below the level of the North Sea. A Cranberry "moss," for instance, bears little resemblance to an alpine swamp or a marshy loch-side, and all these differ widely in their characteristic flora. Yet in the limited space at our disposal we may hope to point out some important differences between the Fens and Scotland in general.

Cladium is a rare west-coast plant in Scotland, where its place is practically taken by *Carex acutiformis* (= *pseudosa*) at the water-sides. The latter is not uncommon in Cambridgeshire, but *C. riparia* is much more abundant, especially near the Fen. In the whole Level *C. inflata* (= *ampullacea*) is a rare plant, while it is plentiful in the North, and becomes even more so as we ascend the hills. North and South furnish plenty of *Carex flacca* (= *glauca*), *C. panicea*, *C. fulva*, *C. flava*, and other common sedges, but the forms of *C. Goodenowii* (= *vulgaris*) are as scarce in our alkaline soil as they are common in the more acid

deposits to the north of the Border, and are almost entirely replaced by *C. data* (= *stricta*). We have no *Carex pauciflora*, *C. dioica*, *C. canescens* (= *curta*), or *C. limosa*, and very little *C. echinata* (= *stellulata*) or *C. paniculata*, though in Wicken Fen *C. paradoxa* replaces the last-named. Again, *C. disticha* and *C. lasiocarpa* (= *piliformis*) are abundant there in places, while they are decidedly local in Scotland. We have not so much as a spike of *Narthecium ossifragum*, but we can show a considerable amount of *Schornus nigricans*, which, however, is most common at Chippenham.

As regards the Grasses, the Fens show less variety than many a Scottish moor. *Molinia caerulea*, which is our staple grass, may be equally common in both places: but we have little besides except *Agrostis calypariz*, *A. alba*, and the two above-mentioned species of *Calamagrostis*, of which both are very rare north of the Border. *Glyceria fluitans* of the ditches is a more or less universal species, and *Glyceria aquatica* is abundant near the Fens, but is not a true fen grass.

Rushes form a large part of the vegetation of a fen, but, except on the dry banks, the only, or almost the only, species to be met with is *Juncus obtusiflorus*, where in Scotland we should find *J. acutiflorus*. *J. squarrosus*, so common on the Northern moors, is entirely absent; and even on the outskirts of the Fenland *J. glaucus*, which is comparatively scarce in Scotland, takes the place in almost every case of *J. communis*.

North and South agree in the fact that Willows and Alders are the usual concomitants of marshy spots; but the species of the former are not necessarily the same. Where *Salix alba*, *S. fragilis*, *S. pentandra*, *S. caprea*, *S. aurita*, and the alpine Willows are to be found, according to altitude, in Scotland, Wicken Fen possesses only *S. cinerea* and *S. repens*, though these are, of course, also Northern forms. The two Buckthorns, so abundant in the Fen, are hardly worth consideration in the North, where only *Rhamnus Frangula* occurs, and then but rarely. Hawthorns are becoming more and more abundant in the Fens, but they do not invade the moors or mosses of Scotland, nor, to any great extent, the low-lying marshes.

Coming to the more lowly vegetation, a striking feature

of the Bedford Level is the total absence of heather or ling, which cover so many acres both of dry and wet moorland elsewhere. This may be due to the alkaline character of the soil, which probably also precludes the growth of the Cranberry (*Vaccinium Oxyccocos*) and the Bog Orchis (*Malaxis paludosa*), while permitting that of the corresponding Fen Orchis (*Liparis Loeselii*). To a similar cause we may assign the great rarity of Sphagnum, only found in minute quantity at Chippenham, while it is represented in the Level generally by a low-growing form of Hypnum.

It will be seen from what has been already said that Scotland can show a much greater variety of plant-life in general in her moors and marshes than can the Fenland, though Wicken Fen itself is richer than any one spot that we are able to name in the North. It will be well, therefore, to conclude this paper by mentioning some well-known plants, without which an account of the Fenland can hardly be considered complete.

The most notable are doubtless the two extinct Groundsels, *Senecio paludosus* and *S. palustris*, of which the former still grew at Wicken in the middle of last century. *Sonchus palustris*, generally coupled with them, and fortunately still existing in Oxfordshire and Kent, is a marsh rather than a fen plant, and may possibly be a survivor of ancient woodland country. *Selinum carvifolium*, first discovered as a British plant at Chippenham and undoubtedly native there, has only since been reported from Horncastle in Lincolnshire. *Limnanthemum peltatum* is extremely abundant in some of the water-courses, especially in the West or Old Ouse and the Bedford Rivers. *Stratiotes aloides* almost fills some of the pits and invades the neighbouring channels, while *Teucrium Scordium* still exists in a few places, though apt to disappear suddenly in a somewhat curious manner.

None of these are native Scottish plants. But we may make many comparisons in other cases. For instance, the Marsh Pea (*Lathyrus palustris*) is plentiful at Wicken, and the Fen Violet (*Viola stagnina*) not uncommon there and at Woodwalton; but *Lathyrus macrorhizus* and *Viola palustris* are absolutely unknown throughout the Bedford Level. We have already mentioned *Liparis* as representing

Malaxis, and *Sium latifolium* as being our most striking Umbellifer, but we might point to *Cicuta cirrosa* as an equivalent to the latter in the Borderland marshes, to *Malachium aquaticum* as taking the place with us of *Stellaria nemorum*, and *Veronica anagallis* of *V. Beccabunga*. *Cardamine amara* is a woodland plant to a great extent in the North: with us it occurs in the Fen willow-holts: but once more it behoves us to remember that the fen country was once well-wooded. We have *Utricularia vulgaris* and *U. minor* in some quantity, but no *U. intermedia*; we have *Parnassia* but little *Pinguicula* or *Drosera*. *Hippuris* is plentiful and is apt to take the place of *Equisetum*, while we have no *E. sylvaticum* or *E. hyemale* at all. *Myrica Gale* cannot be relied upon as an instance, as, though now almost extinct, it is said to have once been plentiful in the Fens: but the genus *Eriophorum* is certainly conspicuous by its absence at the present day, and was apparently always rare with us. *Lustrea Thelypteris* is, moreover, the only Fern of the Level, and in these two cases we again note a great difference from the marshes of Scotland.

The genus *Potamogeton* provides many interesting forms for the botanist to study, and has been ably worked out of late years by Mr. Alfred Fryer of Chatteris, who lives in the midst of the Fen country. We lack many of the Scottish species, notably *P. alpinus* (= *rufescens*) and *P. polygonifolius*—the place of which is entirely taken by *P. coloratus* (= *plantagineus*),—but we are rich in forms of *P. Zizii*, *P. lateropogonius*, and so forth, while *P. Billupsii*, *P. falcatus*, and *P. crassifolius* have been determined as new species by Mr. Fryer, and *P. dilatatus*, *P. decipiens*, and *P. lanceolatus* are only known from a few other counties.

In conclusion, we may mention the effect of salt water in the Fen area, which extends far above the actual influence of the tide. This is shown by the presence of *Scirpus maritimus* at Upware, south of Ely, and at Sutton, on the washes of the Bedford Rivers: while *Juncus Gerardi* has been found in the latter district, and a form of *J. compressus*, possibly derived from the same stock, accompanies *Carex distans* in a field where sea-shells are commonly met with, at Waterbeach near Cambridge.

REPORT OF THE SCOTTISH ALPINE BOTANICAL CLUB,
1910. By ALEXANDER COWAN, Esq.

The Club met at the Spittal of Glenshee Hotel on July 11th, as the members were unable to find sufficient accommodation at the hotel at Clova, where it was originally proposed to hold the meeting.

The district is reached after leaving the railway at Blairgowrie by the road leading north up Glenshee, and it continues after leaving the hotel over the Devil's Elbow on the Cairnwell on to Braemar.

Leave having been very kindly granted to the President of the Club by the representatives of the proprietors, a large extent of very interesting ground was visited, where large quantities of deer were seen; but though a good number of plants were gathered, the members were unfortunate in not finding *Lichenis alpina*, which is known to grow in this district.

The weather during the week was extremely hot and dry: indeed, it was too dry for botanising or walking with any comfort, as there was practically no breeze at all, and the sun was so hot as to be quite oppressive.

On Tuesday, July 12th, the members motored about five miles up the road to within a short distance of the Devil's Elbow, from which point they commenced a long climb and tiring walk in order to visit the rocks at Caenlochan, where the following plants were found:—*Allosorus crispus*, *Alopecurus alpinus*, *Asplenium viride*, *Botrychium lunaria*, *Cerastium alpinum*, *Chrysosplenium alternifolium*, *Cochlearia alpina*, *Carex atrata*, *C. aquatilis*, *C. capillaris*, *C. curta*, *C. dioica*, *C. panicea*, *C. pulicaris*, *C. rariflora*, *C. rigida*, *C. stellulata*, *Draba incana*, *Dryas octopetala*, *Epilobium alpinum*, *Erigeron alpinum*, *Gallium boreale*, *Habenaria viridis*, *Helianthemum vulgare*, *Juncus triglumis*, *Lastrea propinqua*, *Loiselaria procumbens*, *Lysimachia nemorum*, *Lactuca alpinum*, *Parnassia palustris*, *Phleum alpinum*, *Poa alpina*, *Polystichum aculeatum*, *P. lonchitis*, *Potentilla Crantzii*, *Pseud-athyrium alpestre*, *Pseud-athyrium* variety *flecile*, *Pyrola minor*, *Rhinanthus Crista-galli*, *Rubus saxatilis*, *Salix*

herbacea, *S. reticulata*, *Saxusaria alpina*, *Saxifraga hypnoides*, *S. nivalis*, *S. oppositifolia*, *S. stellaris*, *Silene acaulis*, *Solidago virgaurea*, *Splachnum rusculosum*, *Thlaspe alpestris*, *Toxifolia palustris*, *Tridentalis europaea*, *Trollius europaeus*, *Vaccinium uliginosum*, *Vernonia alpina*, *V. Sacatilis*. It will be noted that a very rare moss, *Splachnum rusculosum*, was gathered, having been found by the President to be still fairly abundant on a station where he had found it on a previous visit many years before.

The members had a long walk back to the road where they had left the motor in the morning, and they were all thoroughly tired after such a hard and fatiguing day.

On July 13th, some of the older members of the party, who were feeling the effects of their exertions on the previous day, decided to take things easily, and having motored about four miles up the valley, hunted among the ferns, of which thousands, principally *Lastrea montana* and *propinqua* were growing on the sides of the small burns on the eastern slopes of Carn Mor. One of the members was lucky enough to find a very curious crispy form of the former fern: the pinnae being all crisped and congested so that the plant was easily distinguishable when seen growing alongside the normal form.

Two members of the party who were anxious to find *Lichenis alpina* tried to discover the station where members had found the plant when on a previous visit to Clova, but in this they were unsuccessful. Their efforts were much hampered by the presence of several hundred deer, and many of the stags appeared to resent the intrusion, so much so that it was thought advisable not to further disturb them. In addition to many of the plants found on the previous day, *Cornus seusica* and *Gentiana campestris* were gathered. The day was even hotter and more oppressive than the previous one had been.

On July 14th the members motored over Devil's Elbow towards Braemar, turning up the rough road leading to Glen Callater and Corrie Cander. In Loch Cander was found *Callitriche intermedia*, Hoffm., *Isoetes lacustris*, and *Triglochin palustre*. *Carex atrata*, *C. curta*, *C. pulicaris* and *Juncus triglidus* were also found during the day. In

the Corrie was a large patch of snow, and in its immediate neighbourhood vegetation was only just commencing. Large quantities of *Pseud-athyrium alpestre* were seen, and though most of it was much disfigured through being eaten down by the deer, a few interesting sub-varieties were found, which it is hoped will remain permanent under cultivation.

The heat of the sun may be judged by the fact that two of the members of the party bathed twice during the day in Loch Cander. Two other members who did not accompany the party to Glen Callater, found *Gentiana campestris* in the Glen near the hotel.

On July 15th, the only member of the party remaining spent the day among the ferns growing on the burn sides in the valley to the north of the hotel. Here he found a dwarf erect-growing variety of *Lastrea montana* with short pinnae, similar plants of which have already been found on two previous occasions in Westmoreland, and which is known to fern growers by the name of *angustata*. Several large clumps of it were seen on the side of a burn within a space of about fifty yards. This variety keeps perfectly permanent in cultivation, and is a most interesting sport from the normal type of the fern.

Though nothing very wonderful in regard to plants was found, the meeting will always remain memorable to the members present owing to the wonderful weather experienced, for although they have frequently had their pleasure spoilt and their botanising interfered with by rain and mist, it was quite a new experience, to most of them at all events, to have their work on the hills rendered almost unbearable owing to the extreme heat.

A NEW LEYCESTERIA. By W. W. SMITH.

Leycesteria Belliana, W. W. Smith, sp. nov.

Species *Leycesteria sinensis* Hems. valde affinis sed cum specimine unico ejus speciei (Henry 9692 c) in Herbario Kewensi non quadrat. Ad hoc confer Hook. Icones Plantarum, tab. 2633. Foliis stipulatis, petiolis brevissimis dense strigosis, inflorescentia brevispicata, calycis limbo

5-partito, stylo piloso ab ea specie satis distinguenda. A *Leqestertia stipulata* (Hook. f. & T.) Fritsch, habitu gracili, caule fistuloso glabrescente, stylo piloso inter alia differt.

Frutex ramosus paucipedalis, ramulis $\pm$ albo-pilosulis, mox glabrescentibus, teretibus, fistulosis ad nodos septatis. *Folia* opposita breviter petiolata, membranacea, lanceolata, 5-10 cm. longa, 1.25-4 cm. lata acute caudato-acuminata, basi rotundata vel aliquantulum cordata, supra subglabra vel parce strigillosa, subtus glauca, praeipue in venis $\pm$ rufescenti-strigillosa, margine obscure sinuata rarius ciliolata, venis primariis 5-7 paribus: petiolus 1-3 mm. longus, dense strigosus, stipulae parvae ad 5 mm. longae, ad 3 mm. latae, rotundato-ovatae, saepe perpusillae. *Floris* luteo-albidi 2 cm. longi, sessilis, in spicas 2-vel 4-florigeras brevissimas ramulos laterales terminantes per paria dispositi pedunculis brevissimis, bractee bracteolaeque plures foliaceae rotundato-ovatae vel lanceolatae floribus breviores. *Calycis* dense glanduloso-pilosi tubus 5 mm. longus fusiformis: limbus fere ad unum in lobos quinque aequales, rarius subaequales, lineari-lanceolatos, acutos, 5 mm. longos, persistentes divisus. *Corolla* 15 mm. longa, subaequaliter 5-loba, hypocrateriformis, fere recta, extus glanduloso-pilosa, intus glabra, nisi intra mediam partem qua filamenta cum tubo conjuncta lobis rotundatis 3-4 mm. longis. *Stamina* brevissime exserta summo triente glabro parte cohaerente villosula. *Ovarium* 5-loculare multiovulatum stylo stamina paulo superante filiformi, summo triente glabro, reliqua parte dense glanduloso-pilosa, stigmatibus capitato. *Fructus* immaturus angularis albidis glanduligeris capillis dense vestitus: semina vix matura 7.5 mm. longa, irregulariter ovoidea, subcompressa, minute punctulata, albida, nitentia.

Sikkim:—in monte Tonglo, 10,000 ped. alt., prope fines nepalenses 154 *Herb. Sikkimense* T. Anderson coll. anno 1862: inter montes pluviosos prope hospitium Karponang dictum ad 9-10,000 ped. alt. 2996 *Smithi*. Typi in herbariis Kewensi et Edinburgensi et Calcuttensi conservati.

This species is rare in the Sikkim hills, and ranges higher than *Leqestertia stipulata*. The specific name is in honour of Mr A. C. Bell, I.C.S., British Resident in Sikkim, who has made botanical collections in Chumbi and elsewhere. It



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HYLIS 'ERI- BE LAM W.W Smith

ought to grow as well as *Legesteria formosa* in European gardens, but, so far, seeds have not been available. I am indebted to Mr W. G. Craib, of Kew Herbarium, for kindly comparing the plant with Henry's Yunnan specimen.

BORTHWICKIA, A NEW GENUS OF CAPPARIDACEÆ.

By W. W. SMITH.

Borthwickia genus novum.

Apud *Capparidoidibus-Capparideis* (Pax): maturo fructu adhuc deficiente locus dubius, interim post. *Ritchieam* R. Br. positum est sed etsi frutex, ex affinitate *Polanisia* esse videtur. *Frutex* foliis oppositis trifoliatis: *petala* sex aequalia in latissimum unguem et laminam minorem discreta: *stamina* in androphori brevis crassi apice inserta: *fructus* longe stipitatus 4-6 locularis. Species unica burmanica. Generis nomen honori cl. Alberti Borthwickii scientiæ doctoris et viri re botanica eruditi.

Borthwickia trifoliata, W. W. Smith, sp. nov.

Planta inermis, altitudine ignota, superior pars in scheda 40 cm. longa. *Caulis* angulatus, striatus, subcompressus præsertim apud nodos ad 10 cm. remotos, parce minute puberulus, mox glabrescens, racemo terminatus. *Folia* opposita, rarius subopposita, usque ad 8 cm. petiolata, foliolis tribus lanceolatis acuminatis, basi cuneatis, 7-15 cm. longis, 2-6 cm. latis, 1-2 mm. petiolulatis, supra glabris, infra in nervis (6-9 paribus) nervulisque rufo-pilosulis. *Flores* in terminalem racemum densum, in fructu ad 10 cm. auctum, compositi. *Bractea* 1 cm. longæ filiformes pilosulae. *Pedicelli* 5 mm. longi, rufo-pilosuli, in fructu ad 15 mm. aucti. *Sepala* duo: neque in aperto flore neque in gemma aliorum interiorum sepalium vestigia vidi: 13-14 mm. longa, 5-6 mm. lata, oblonga, obtusa, valvata, in aperto flore ad basin discreta, serius decidua. *Petala* sex, aequalia, 1-seriata (ideoque duo ut interiora sepala non habenda), valvata, divisa in unguem loriformem, 5 mm. longum, 1.5 mm. latum, villosulum, et in laminam, 3 mm. longam, 1.5 mm. latam, ovatam, glabram, obtusam, minute dentatam, 6-8 nervatam. *Stamina* in apice androphori 4-5 mm.

longi inserta. 40-50, 14-16 mm. longa, omnia fertilia, libera, æqualia, filamentis filiformibus, antheris ovalibus, nec oblongis, dorso basi affixis. *Oecarium* longe stipitatum 4-6 costatum, stigmatē sessili, glabrum, 7-8 mm. longum, 4-6 locale. *Fructus* immaturus ad 4-5 cm. elongatus, 2-3 mm. latus, carnosulus, seminibus haud multis, multum compressis, reniformibus, 3 mm. longis, gynophoro ad 2-3 cm. aucto.

Burma:—Ad vicum Loi-mwe dictum apud pagos shanenses australes, circ. 1500 ped. alt. 714, 1325, R. W. MacGregor. Typi in herbario Calcuttensi conservati.

DESCRIPTION OF PLATE.

- Figure A. Branch with inflorescence. $\times 1$.
 .. B. Flower dissected. $\times 2$.
 .. C. Petal. $\times 4$.
 .. D. Section of ovary; seed. $\times 2$.

PHÆOTHAMNION CONFERVICOLUM, LAGERHEIM, AND ITS FIRST RECORDED APPEARANCE IN GREAT BRITAIN.* By F. L. M'KEEVER, F.R.M.S.

The large class of Algae, the Phaeophyceae or Fucoidae (in older books usually called Melanosporae), are almost entirely inhabitants of the sea, and only a few families of the order Syngeneticeae are found in fresh water. G. S. West (1) enumerates seven families of this order, and of these only four are represented in Great Britain. I was fortunate enough to find the only member of the fifth family, the Phaeothamniaceae among other Algae collected from the Elf Loch on the Braid Hills near Edinburgh, and a few remarks on this plant might be of some interest.

Phaeothamnion confervicolum was first described by the Swedish botanist G. Lagerheim, who published his description, together with a very complete life-history, in 1884 (2). He had found this Alga in several localities in Sweden as an epiphyte on various filamentous Chlorophyceae, and as

* "Annals of Scottish Natural History," No. 77, January 1911.



Del. A. N. Banerjee
BORTHWICKIA TRIFOLIATA W. W. Smith.

the brown chromatophore distinguishes it at once from all other known freshwater Algae, he established the new genus *Phæothamnion*. He suggests, however, to create a sub-family, *Phæothamniaceæ* of the *Chaetophoraceæ* (Harv.) Wittr., the latter being a family of the *Chlorophyceæ* or Green Algae.

The description of this Alga given by Lagerheim (2) is as follows:—

"Thallus confervoides (non mucosus) monopodialiter ramosus, ramis superioribus suberectis, ramis inferioribus patentibus, algis majoribus adnatus. Cellulæ vegetativæ cylindricæ vel subclavatæ vel ovoideæ; cellulæ terminales obtusæ vel acutatae, nunquam piliferae; cellula basalis subhemisphaerica, basi in disculum dilatata; membrana cellularum tenuis et hyalina, septis incrassatis; chromatophoræ laminaeformes, parietales, fusco-virides vel olivaceæ (colore orto e chlorophyllo cum phycoxanthino mixto). Zoosporangia intercalaria e cellulis vegetativis orta, eadem forma ac cellulæ vegetativæ. Zoospore binæ, bipartitione contenti zoosporangii ortæ, olivaceo-virides, puncto rubro nullo, ciliis vibratoriiis binis in fine anteriore zoospore positæ præditæ, per ostium poriforme zoosporangii examinantes, sine conjugatione germinantes. Cellulæ vegetativæ (membrana in mucum gelatinosum mutata) bipartitione succedanea in statum palmellaceum transeuntes."

The dimensions given by Lagerheim are as follows:—

Long. cell. veg. 6-10 μ ; lat. cell. veg. 4-8 μ .

" " apic. 6-12 μ ; " " apic. 4-6 μ .

" " bas. 5-6 μ ; " " bas. 9 μ .

" zoosporang. 6-10 μ ; " zoosporang. 5-8 μ .

Diam. orif. zoosporang. 3 μ ; diam. zoosporang. 4-5 μ .

" cell palmell. 4 μ .

Total height of plant up to 100 μ .

Twenty-one figures on one plate were also published in Lagerheim's paper (2).

The plant was distributed in Wittrock and Nordstedt's "*Algæ aquæ dulcis exsiccatae*," fasc. 13, No. 608.

Two years later this Alga was described by A. Hansgirg in the first volume of his "*Algaflora of Bohemia*" (3), and he placed the family *Phæothamniaceæ* under the order *Syngene-*

ticæ of the Phaeophyceæ or Brown Algae. Hansgirg's description and sketch enabled me to identify the Alga I had found as an epiphyte on aquatic phanerogams in the Elf Loch, especially as it was easily distinguishable from all the other freshwater Algae by its brown chromatophore. Professor G. S. West of Birmingham, to whom I sent some living specimens of *Phaeothamnion*, confirmed my identification. He had already pointed out in 1904 (1) that this Alga would be found one of these days in Great Britain, and, as nearly all freshwater algae are cosmopolitan, it is not surprising that it should be discovered in this country also. As far as I can ascertain, it was recorded after 1886, the date of Hansgirg's publication, from the following localities:—

1888. G. Lagerheim (5): *Sphagnum* near Halensee, and on *Cladophora* from Tempelhof, both places near Berlin; on *Vaucheria* in the Botanical Gardens of Würzburg, Bavaria, and also from Freiburg in the grand duchy of Baden.

1892. Borzi (6) in Sicily, near Messina.

1892. A. Hansgirg (4), in the second volume of his "*Alga-flora of Bohemia*."

I could not find any other record of *Phaeothamnion* except one in 1905, published again by A. Hansgirg in his "*Alga-flora of Lower Austria*" (7). The only other investigation regarding the life-history of *Phaeothamnion confervicolum*, besides that given by G. Lagerheim in 1884 (2), was published by Borzi of Italy in 1892 (6). There are several important points in which Borzi differs from Lagerheim, such as the position of the zoospores and the presence of a red pigment spot. Lagerheim reports bi-ciliated asexual zoospores only, without a pigment spot, while Borzi has observed gametes and a red eye spot as is usually found in the zoospores of the higher forms of Algae. Lagerheim distinctly states that the two cilia of equal length are inserted in the anterior part of the zoospores, and Borzi describes the cilia to be directed laterally as observed among the Phaeophyceæ. It would therefore be desirable to re-investigate the motile stages of *Phaeothamnion*, as the position of the cilia is of considerable importance for the systematist.

I first observed this Alga in its younger stages growing on the rootlets of *Lemna minor* and the leaves of some aquatic phanerogams, but it grew later on in great profusion together with *Coleochaete scutata*, Bréb., on the sides of the glass vessel in which I preserved various species of Algae collected from the *Eli Loch*. Although kept in cultivation for over two months during August and September 1910, I could only observe the vegetative stage of this plant. After an absence of several weeks I found *Phaeothamnion* had entirely disappeared from the culture, and to my great regret I was unable to contribute anything to our knowledge of the life-history of this alga.

A *Palmella*-stage such as is reported both by Lagerheim and Berzi I was unable to obtain even by varying the conditions under which the plant grew in "hanging-drop" cultures. Empty cells showing the characteristic circular opening by which the zoospores had escaped I found several times, and also in one instance a few zoospores, but owing to lack of time I was unable to fix and stain these in order to investigate the number and position of the cilia.

Regarding the remarkable colour of the chromatophore, I can confirm Lagerheim's and other investigators' statements as to the action of a weak alcoholic solution, which dissolves the brown colouring matter and leaves the green chlorophyll, and exactly the same effect can be obtained with the brown chromatophores of the *Diatomaceæ*.

The systematic position of *Phaeothamnion* and the other lower *Phaeophyceæ* was thoroughly investigated by A. Scherffel in 1900 (8) and 1901 (9), and also by Oltmanns in 1904 (10). De Toni in his "*Sylloge Algarum*," vol. iii., published in 1895 (11), places *Phaeothamnion*, following Hansgirg, under the *Phaeophyceæ* or *Fucoidae*. N. Wille, in Engler and Prantl's "*Natürliche Pflanzenfamilien*" (12), however, regards this Alga, as was suggested by its discoverer Lagerheim, as a genus of the family *Charophoraceæ*, and therefore one of the *Chlorophyceæ* or Green Algae.

In Oltmanns's great work on the Algae (10), *Phaeothamnion* and all the *Unicellular Brown Algae* are considered apart from the class *Phaeophyceæ*, and as being nearer related to the *Flagellatæ* than to the true Algae. *Phaeothamnion* is regarded by him as one of the *Chrysomonadineæ*, and

described in an "Anhang zu den Chrysomonadinen" (see vol. i. pp. 12 and 15, vol. ii. pp. 18-19).

G. S. West in his "Treatise on the British Freshwater Algae," published in 1904, as previously stated, mentions the following seven families as the most important of the freshwater Phæophyceæ:—

Fam. HYDRURACEÆ, with *Hydrurus*, Ag.

.. CRYPTOMONADINACEÆ, with *Cryptomonas*, Ehrenb.

.. CHRYSOMONADINACEÆ, with *Syncrypta*, Ehrenb.:

Synura, Ehrenb.; *Uroglena*, Ehrenb.

DINOBRYACEÆ, with *Dinobryon*, Ehrenb.

PHÆOCAPSACEÆ, with *Phaeocystis*, Lagerh.: *Phaeococcus*, Borzi;

Phaeosphaera, West and G. S. West;

Stichoglossa, Chodat; *Phaeochlorella*, Lemm.;

Phaeodactylon, Bohlin.

.. CHORISTOCARPACEÆ, with *Pleurocladia*, A. Br.

.. PHÆOTHAMNIACEÆ, with *Phaeothamnion*, Lagerh.

Up to 1910 only four of the above families were known to be represented in Britain.

In Thoms's "Kryptogamen Flora von Deutschland" (13), Migula has apparently followed Ottmanns by regarding all the lower Phæophyceæ as Flagellatæ or rather as intermediate stages between them and the Algæ, as Phæothamnion, as well as Hydrurus, Phaeocystis, and other Syncreticæ, are mentioned neither in vol. i., treating of the Myxophyceæ, Chlorophyceæ, and Bacillariæ, nor in vol. ii., devoted to the Phæophyceæ and Rhodophyceæ. A copy of figs. 7 and 10 of Lagerheim's plate published in 1884 (2) appears, however, on plate 38 of vol. i. in Migula, but without any description in the text.

A bibliography of Phaeothamnion as far as I have been able to ascertain, is given below.

BIBLIOGRAPHY.

- (1) G. S. WEST.—A Treatise on the British Freshwater Algae, Cambridge, 1904, p. 45, and following.
- (2) G. LAGERHEIM.—Ueber Phaeothamnion, eine neue Gattung der Süss-wasser-algen. Bihang till K. Svenska Vet. Akad. Handlingar, ix. No. 19, Stockholm, 1884.
- (3) A. HANSGIRG.—Prodromus der Algenflora von Böhmen. Vol. i., Prague, 1886, p. 31.

- (4) A. HANSGIRG.—Vol. ii., Prague, 1892, p. 207.
- (5) G. LAGERHEIM.—Sopra alcune Alghe d' acqua dolce nuove o rimarchevoli. *Notarisia* iii., fasc. 12, p. 592.
- (6) A. BORZI.—Intorno allo sirluppo sessuale di alcune Feoficee inferiori. *Atti del congresso botanico internazionale di Genova*, 1892, pp. 454-462. Tav. xvii.
- (7) A. HANSGIRG.—Grundzüge der Algenflora von Nieder-Oesterreich, *Beitr. z. bot. Centralblatt*, 1905, xviii., Abt. ii. Heft 3, p. 433.
- (8) A. SCHERFFEL.—*Phaeocystis globosa* nov. spec. nebst einigen Betrachtungen über die Phylogenie niederer insbesondere brauner Organismen. *Wissenschaftl. Meeresuntersuchungen*, Abt. Helgoland, N.F. iv., 1900. 1^{tes} Heft.
- (9) A. SCHERFFEL.—Kleiner Beitrag zur Phylogenie einiger Gruppen niederer Organismen. *Botan. Zeitung*, 1901, 59, pp. 143-158.
- (10) F. OLTMANN.—Morphologie und Biologie der Algen, vol. i., 1904; vol. ii., 1905.
- (11) DE TONI.—*Sylloge Algarum*, vol. iii. (Fucoideæ). Patavii, 1895, p. 120.
- (12) N. WILLE.—Engler and Prantl's *Natürliche Pflanzenfamilien*, I. Teil, ii. Abt., p. 96. Leipzig, 1897.
- (13) THOMÉ'S *Kryptogamen Flora von Deutschland*, etc., bearbeitet von W. Migula. Band ii., Algen. I. Teil. Gera, 1907.

FURTHER RECORDS OF FLOWERING-PLANTS (PHANEROGAMS)
AND FERNS FROM THE ISLE OF MAY. By WILLIAM
EVANS, F.R.S.E.

The following botanists have recorded their observations on the Flora of the Isle of May, at the mouth of the Firth of Forth:—

John Sadler ("Trans. Bot. Soc. Edin.," vol. xi. pp. 390-392, 1873).

John Rattray (*ibid.*, xvi. pp. 115-121, 1884).

William Evans (*ibid.*, xxiii. pp. 348-351, 1908; and xxiv. pp. 91-93, 1910).

George West ("Proc. Roy. Soc. Edin.," xxx. pp. 173-177, 1910).

With the exception of my own—which are concerned entirely with the Mosses and Hepatics—these papers deal more or less with the Phanerogams and Ferns.¹ Sadler, who visited the island along with Professor J. H. Balfour

¹ A few Fungi from the May have been recorded by Mr. A. B. Steele and myself ("Ann. Scot. Nat. Hist.," 1908, p. 58, and 1910, p. 58). To these there falls to be added *Crucibulum vulgare*, Tul., which I found in Sept. 1910 growing on a piece of old wood in the south garden.

and others in August 1871, recorded eighty-three of the former, and one of the latter, namely, *Asplenium maritimum*. To that list Rattray added twenty, including a fern, *Lastreæ* (sic) *Felix-fermina*. West mentions other eight—among them a third fern, *Asplenium Ruta-muraria* seen by him in August 1905.

The undernoted further additions to the list have at one time or another been collected by me on the island: they comprise twenty Phanerogams and two Ferns. Some of the Phanerogams flower early, which probably accounts for their absence from previous records. A number are garden weeds, a class from which a few more additions might doubtless have been made had one cared to look specially for them.

It would seem that the Flora of the island has undergone some changes in recent years. Several of the plants previously recorded—*Mertensia maritima*, *Lotus corniculatus*, and *Sedum acre*, for instance—I am unable to find: while others stated to have been common are, in my experience, scarce and *vice versa*. For instance, Mr. West speaks of *Bellis perennis* (the daisy) as "scarce near the houses"; this year, in June, the grassy banks by the roadside from the landing stairs to the lighthouse, and down by the harbour, etc., were literally white with daisies. On the other hand, *Galium verum*, referred to as common, I have had difficulty in finding: its congener, *G. saxatile*, however, is plentiful. Since the cropping of the enclosures (now in grass) was discontinued, a number of field weeds are quite likely to have disappeared. The introduction of a few plants of the Sea Buckthorn (*Hippophae rhamnoides*) to the engineer's garden this spring should, perhaps, be mentioned, so that its origin may be known in the event of the shrub becoming established on the island.

LIST OF ADDITIONS.

Ranunculus Ficaria, L. Fairly plentiful in the beginning of June 1910, and again this year, immediately to the north of the lighthouse.

Pumaria officinalis, L.—In garden south of the engine-house, June 1910 and 1911.

Capsella Bursa-pastoris, Medic.—Common about the gardens and adjoining ground.

Viola sylvatica, Fries (? *Riviniana*, Reichb.).—On 2nd June this year I observed about a dozen plants of what I have been accustomed to call *Viola sylvatica* in flower on a grassy bank close to the lighthouse. The lighthouse keepers say they first noticed it there two years ago.

Lychnis dioica, L. (*diurna*, Sibth.).—A group of less than a dozen plants on steep bank on the south side of the loch, July 1910 and 1911.

Vicia lathyroides, L.—In some abundance in front of the lighthouse in beginning of June 1910, and on bank near the harbour, 2nd June 1911.

Apium graveolens, L.—Specimens collected on the May in 1879 are in my herbarium.

Chrysanthemum segetum, L.—A single plant in flower in a patch of oats, south garden, July 1911.

Anagallis arvensis, L.—Two or three plants in garden, July 1911.

Convolvulus arvensis, L.—In flower by side of path in south garden, July 1910, and again 7th July 1911. Has, I am told, been there for a number of years.

Veronica agrestis, L.—A common weed in the gardens, August 1910 and July 1911.

Lamium hybridum, Vill. (*incisum*, Willd.).—Several plants seen about the gardens in August 1910; common, July 1911.

Euphorbia Peplus, L.—A good many plants in south garden, July 1911.

Juncus Gerardii, Loisl.—In a moist spot close to the sea on the south-east of the island, July 1910; and at one higher up this year.

Koeleria cristata, Brit. auth. (? *britannica*, Domin).—Common on the higher, rocky parts, June 1910 and 1911.¹ Noted also in June 1899.

Dactylis glomerata, L.—Common about the gardens and grass enclosures.

Poa pratensis, L.—At side of garden, etc., June 1911.

Festuca duriuscula, L.—At foot of wall round south garden, etc., June 1910 and 1911.

¹ Since these notes were put together, I have submitted specimens to Mr. G. C. Druce, and he says they are *K. britannica*, but not an extreme form.

F. elatior, L.—Two or three plants on low ground south of harbour, July 1911.

Nardus stricta, L.—On 8th June this year my son drew my attention to this grass on a knoll above the harbour, and a week later I found it in abundance to the north of the lighthouse.

Lastrea dilatata, Presl.—Among grass on low rock-ledges in several places in the southern half of the island, September 1910. A small form, such as one meets with on the hills.

Polypodium vulgare, L.—A good-sized patch on steep bank, south of the loch, September 1910. It had been sadly spoiled by excursionists in the belief that it was the sea spleenwort.

The two species above recorded, and *Asplenium marinum*, which grows in several places on the cliffs and in the caves, are the only ferns I have seen on the island.

